

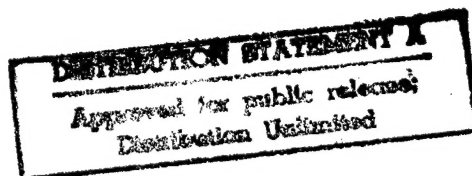
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6 FEBRUARY 1987

USSR Report

MACHINE TOOLS AND METALWORKING EQUIPMENT



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6 FEBRUARY 1987

USSR REPORT
MACHINE TOOLS AND METALWORKING EQUIPMENT

CONTENTS

INDUSTRY PLANNING AND ECONOMICS

Machine Building Industry's Tasks, Goals Updated (SOTSIALISTICHESKAYA INDUSTRIYA, 12 Nov 86)	1
Machine Tool Industry Achievements for September 1986 (SOTSIALISTICHESKAYA INDUSTRIYA, 12 Oct 86)	10
Machine Building Key to Acceleration (S. Ovsienko; KRASNAYA ZVEZDA, 28 Sep 86)	12
Meeting on High Output, Resource-Conserving Technologies (I. Glyanko; SOTSIALISTICHESKAYA INDUSTRIYA, 4 Nov 86)	14
Engineers Discuss New Documentation Procedures (A. Semenov; STROITELNAYA GAZETA, 12 Nov 86)	16
BSSR Machine Tool Industry Lagging, Defects Criticized (Editorial; SOVETSKAYA BELOROSIYA, 27 Oct 86)	18
Supply, Delivery Issues in Machine Building Discussed (R. Lynev; IZVESTIYA, 3 Nov 86)	21
Re-Equipping Blank Manufacturing in Machine Building (L. F. Krayev; TEKHNLOGIYA I ORGANIZATSIYA PROIZVODSTVA, No 4, Apr 86)	25
Work Station Rationalization in Machine Building Enterprises (Ye. I. Marchenko; Yu. F. Panov; TEKHNLOGIYA I ORGANIZATSIYA PROIZVODSTVA, No 4, Apr 86)	27

Economic Factors in Introduction of NC, FMS Systems (G. D. Grigoryan; IZVESTIYA AKADEMII NAUK SSSR: SERIYA EKONOMICHESKAYA, No 4, Jul-Aug 86)	30
Reorganization Plan Proposed for General-Purpose Machine-Building (F. V. Kokushkin, Ye. V. Rudneva; IZVESTIYA AKADEMII NAUK SSSR: SERIYA EKONOMICHESKAYA, No 5, Sep-Oct 86)	44
Response To Call for Tighter Control on Foreign Imports (B. Rachkov; EKONOMICHESKAYA GAZETA, No 39, Sep 86)	60
Ineffective Institute Role in Retooling Criticized (M. Khabinskiy; EKONOMICHESKAYA GAZETA, No 43, Oct 86)	65
Improving 'Tools of Labor' Statistics (V. Gumenyuk; VESTNIK STATISTIKI, No 3, Mar 86)	68
Defining Technical Level of Development of Machine Manufacturing Enterprise in Terms of Generalized Indicator (Yu. T. Bubnov; VESTNIK MASHINOSTROYENIYA, No 3, Mar 86)	69
Development and Manufacture of General Machine Building Products (O. V. Yaremenko; STANDARTY I KACHESTVO, No 5, May 86)	70
METAL-CUTTING AND METAL-FORMING MACHINE TOOLS	
Impact of Increased Use of Special and Specialized Machine Tools (Ye. I. Kravtsov; MASHINOSTROITEL, No 8, Aug 86)	71
New Materials, Technology for FMS Systems, Machine Tools (Yu. A. Starostinetskiy; NARODNOYE KHOZYAYSTVO BELORUSSII, No 8, Aug 86)	73
Georgian Tool Industry Excessive Equipment Overhauls (Levan Turmanidze; ZARYA VOSTOKA, 30 Sep 86)	79
Selecting Production-Efficient Modes of Tool Operation for Rough Machining on Heavy and Large Lathes (G. L. Khayet, et al; VESTNIK MASHINOSTROYENIYA, No 3, Mar 86)	81
Cutting Portions of Tools From Standardized Blanks (V. N. Konoplev; MASHINOSTROITEL, No 4, Apr 86)	82
Influence of Relative Tool-Blank Oscillations on Effectiveness of Use of Modern Cutting Materials (A. L. Vilson; et al.; STANKI I INSTRUMENT, No 4, Apr 86)	83
Independent Device for Preparation, Monitoring and Diagnosis of Punch Tapes for Numerically Controlled Machine Tools (Yu. S. Sharin, B. V. Vershinin; MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA, No 7, Jul 86)	84

Automation of Loading of Metal-Cutting Machine Tools (V. P. Bobrov; MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA, No 7, Jul 86)	84
Optimization of Control Programs for Numerically Controlled Machine Tools (M. A. Levin; MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA, No 7, Jul 86)	85
OTHER METALWORKING EQUIPMENT	
Benefits, Applications of Diagnostic Instruments Viewed (V. Belyayev; MOSKOVSKAYA PRAVDA, 13 Nov 86)	86
The Powerful Presses of Voronezh (A. T. Kruk, et al.; NAUKA V SSSR, No 3, Jan-Feb 86)	89
Laser Working of Hard Alloy Blanks (V. S. Kovalenko; V. P. Dyatel; MASHINOSTROITEL, No 4, Apr 86)	90
AUTOMATED LINES AND AGGREGATED MACHINING SYSTEMS	
Competition Results for Innovative Polymer Material Processing Equipment (M. G. Dranovskiy, L. N. Novichkova; MASHINOSTROITEL, No 8, Aug 86)	91
Workability of Materials on Numerically Controlled Machines (A. V. Kibalchenko, et al.; MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA, No 4, Apr 86)	96
Selection of Equipment for Automating Assembly of Products in Series and Massive Production Facilities (A. A. Gusev; MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA, No 4, Apr 86)	96
Automation of Monitoring of Vibration Treatment Process With Type SKPV-6 Equipment (B. N. Kartyshev, V. I. Omelchenko; MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA, No 4, Apr 86)	97
ROBOTICS	
Use of Increased Automation in Machine Processing-Industries Discussed (V. I. Zagurskiy; MASHINISTROITEL, No 8, Aug 86)	98
Automated Conveyors, Automation Attitudes Discussed (Aleksandr Shchegolev; SOVETSKAYA ROSSIYA, 16 Sep 86) ...	106
Training of Automation Service Personnel Discussed (SOTSIALISTICHESKAYA INDUSTRIYA, 25 Oct 86)	110

Domestic Answers to Super Computers, Robots Sought (Ye. Kryshelnitskiy; STROITELNAYA GAZETA, 5 Nov 86)	112
Forging Shop Robots (V. V. Karzhan; NAUKA V SSSR, No 3, Jan-Feb 86)	114
Improved Repair of Programmed Control Machine Tools and Robots (N. N. Ivanova, I. N. Vorobyev; MASHINOSTROITEL, No 4, Apr 86)	115
Special Clamp Device for Industrial Robots (R. A. Aliev, Z. I. Farkhadov; MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA, No 7, Jul 86)	116
PROCESS CONTROLS AND AUTOMATION ELECTRONICS	
The Concept of the 'Module' in Technology (A. M. Lyubavin; STANDARTY I KACHESTVO, No 5, May 86) ...	117
TECHNOLOGY PLANNING AND MANAGEMENT AUTOMATION	
Use of Electric Working in Tool Manufacture (A. I. Generalov, V. Yu. Veroman; ENERGO MASHINOSTROYENIYE, No 4, Apr 86)	118
Automation of Selection of Measurement Tools in an Automatic Process Planning System for Mechanical Working of Power Machine Building Parts (V. V. Kalnitskiy; ENERGO MASHINOSTROYENIYE, No 4, Apr 86)	118

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INDUSTRY PLANNING AND ECONOMICS

MACHINE BUILDING INDUSTRY'S TASKS, GOALS UPDATED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 12 Nov 86 p 2

[TASS article: "Fundamental Tasks of the Machine Builders"]

[Text] The machine-building complex is the foundation of technical progress. Its key role in the reconstruction of the national economy was emphasized anew by the June (1986) Plenum of the party Central Committee. In order to resolve the tasks posed by the 27th CPSU Congress, it is essential to modernize Soviet machine building rapidly, reshaping it for the output of equipment systems and complexes of the highest technical and economic level for all sectors of the national economy. An important role in this is allotted to the machine builders of Leningrad, one of the leading industrial centers of the country.

A meeting of party and operational leaders of the machine-building enterprises of the city and oblast was held here recently at the Elektrosila Production Association imeni S.M. Kirov. CPSU Central Committee Secretary and CPSU Central Committee Politburo member L.N. Zaykov took part in it. In his speech, he stated:

The dynamics of the processes occurring in the life of the country are especially apparent in the activity of Leningrad machine-building enterprises, a number of which I have visited. Fresh in all of our minds are the words of CPSU Central Committee General Secretary M.S. Gorbachev, spoken here on Leningrad soil in May of last year, that "the Leningrad party organization, the working class of Leningrad and all laborers of the city and oblast are the leading detachment of the Soviet people and the reliable support for the Leninist Central Committee in all of the sharp turns of history in the past and in the realization of the historic tasks of the present, also complex stage in the development of our society."

Today, when the path toward initiative, independence and creativity is so wide open, it is, of course, more difficult to work, but it is also more interesting and captivating. I do not believe that these words are an exaggeration. We are all witness to the fact that after the April (1985) Plenum of the CPSU Central Committee and the 27th Party Congress, our life is

being consistently renewed and the best traditions of our people are being resurrected.

The selfless labor of the Soviet people in implementing the policy of accelerating the social and economic development of the country is generating positive results in all sectors of the national economy. The targets for the majority of economic indicators are being fulfilled.

It is fundamentally important that long-term strategic growth factors have begun to be included more fully in operation--acceleration of scientific and technical progress, intensification, improvement of the structure of production, a restructuring of the investment process and an increase in product quality and resource conservation.

At this meeting, I would like to exchange opinions about ways of resolving the tasks that have been advanced for machine building by the party in modern times. M.S. Gorbachev emphasizes that a sharp qualitative turning point in the development of machine building is a key issue of the internal economic policy of the CPSU and of the transition of all sectors of the national economy onto an intensive path.

In reality, time has placed machine building in the vanguard of not only an economic and technical restructuring, but a restructuring of thought as well. Whereas the chief battlefield for conducting the new economic policy of acceleration and restructuring is the economy, the weaponry with the aid of which victory can be achieved is being created by the machine builders. This position is clearly and unambiguously formulated by the party.

Raising the efficiency of the economy, implementing the projected structural shifts, resolving social tasks, reinforcing the defensive capability of the country and its international reputation, increasing the attractive power of our economic model, developing trade with foreign countries--all of these most major problems are bound up in a tight knot by the results of machine-building restructuring. Without a powerful qualitative spurt in machine building, it is impossible to ensure the fulfillment of the projected plans. Thus, the discussion concerns issues of both economic and political significance.

The party Central Committee, deeply comprehending all of the stages of economic construction and its rises and falls and extracting lessons from the past, has come to a fundamental scientifically based conclusion on the rapid and priority development of machine building and, proceeding from that, has proclaimed the current five-year plan the five-year plan of machine building.

The CPSU Central Committee and the Soviet government have arrived at additional cardinal resolutions on accelerating the development of the complex of machine-building sectors. The fact that the CPSU Central Committee Politburo considered it essential to advance these resolutions, as you know, for the consideration of the June Plenum, where they received full support, speaks of their exceptional importance and adherence to principle.

All that is at the disposal of our economy has been given to machine building. The construction and development of a number of enterprises in other sectors

has been suspended for a year or two. The management of the complex was restructured ahead of the others, and large capital investments have been allocated. In short, everything has been given to a maximum.

The assigned tasks are unconventional. And the ways of realizing them and approaches to them should also be unconventional. Machine building should outstrip the industry of the country overall by more than 1.7 times in rate of product increase (the rate of increase for machine building will total 43.2 percent, while it will be 25 percent for industry overall). It is also not superfluous to note that over the last five-year plan, industry overall grew at a rate of 19.9 percent, while machine building grew at 25.3 percent.

In the years under consideration--over 6-7 years in all--the machine builders must reach the highest world standards in the parameters of basic products. The task is revolutionary, without analogy in practice. All is new here--the scale, the depth, the strictly specific nature of the projected limits and time periods. This work will require a full mobilization of forces and full commitment. There are simply no other possibilities or different ways.

In evaluating the results of the past period of the first year of this five-year plan, further noted L.N. Zaykov, it is possible to note with satisfaction that the policy of accelerating the development of machine building is basically being sustained. Increasing the output of technology takes place basically through the equipment, machinery and instruments that determine the acceleration of scientific and technical progress. Thus, the production of flexible modules increased by 2.7 times, industrial robots by 1.9 times, machining-center-type machine tools by 1.5 times, metal-cutting machine tools and press-forging equipment with numerical control and rotary and rotary-conveyor lines by 1.3 times and computer control complexes and power equipment for nuclear power plants by 1.2 times.

From a positive aspect, new management methods are manifesting themselves as well. Most noteworthy is the attention to questions of the economic efficiency of operational activity. The creative activeness of labor collectives has increased considerably. The managers of those sectors, associations and enterprises that make up the most progressive elements of the economic mechanism are acting properly.

Thus, the first steps in the direction indicated by the 27th Party Congress have been made by the machine builders. At the same time, it cannot fail to provoke alarm that the opportunities that domestic machine building has at its disposal are still not being utilized fully. Serious shortcomings are permitted in the observance of plan discipline, the fulfillment of contract obligations, the raising of the technical level and quality of product output and the economy of material and technical resources.

In other words, the spirit of restructuring has still not, unfortunately, become the core of everyday activity at all levels of enterprise and association management. Still powerful are not only an inertia of thought, but slowness in the adoption of resolutions and sluggishness in bringing them to life.

This and only this evaluation is given by the CPSU Central Committee to those negative phenomena that remain in this or that section of economic and cultural construction. This means, further stated L.N. Zaykov, that all of the main work is ahead. Here are the paramount problems toward which I would like to direct attention:

First--raising the technical level of quality and marketability of machinery, equipment and instrument output, whence everything should begin. This is the point of departure of all the work. Why is the question posed in this manner? In the coming year 1987, machine building should produce no less than 38 percent of the most important types of products that meet world standards. The level is high in and of itself, but as early as by the end of the five-year plan, new-generation equipment should make up 80 to 95 percent of machine-building production.

It should also not be forgotten that for too long, our personnel have been accustomed to the average level and have been oriented toward diminished criteria, often passing them off as the best. A philosophy of imitativeness has been confessed.

Of course, the assigned tasks will not be resolved by those specialists that have grown accustomed to copying foreign technology and are nourished by well-known ideas, even with the aid of the most modern SAPRs [computer-aided design systems], without a restructuring. A fundamental restructuring of the whole system of scientific research and experimental design work is needed, and it must be done, moreover, on the run. Shortcomings in plans today are shortcomings for 15-20 years ahead, a disease of future production, insufficient productivity and low efficiency of equipment.

The main thing today is a new approach to the role of the designer, the process engineer, the engineer and all the creators of progressive equipment and technology. In the last two years, the CPSU Central Committee and the Soviet government has done everything possible to remove the organizational and economic barriers that have hindered a creative approach to the matter. The conditions of wages have been radically altered, limitations in the wages of specialists have been removed and freedom in the choice of forms for organizing their labor and forming creative collectives has been granted.

These resolutions, which were striven for for so long, however, are being fulfilled today in half measures, including at a number of Leningrad machine-building enterprises. Who of all people but you, comrades, initiators of a new approach to payments for engineering and technical labor, need be made an example for the elimination of all causes for sliding in new methods in organizing and compensating the labor of specialists? It should follow from this that an active point of view of the developer and scientist aimed at the standard of tomorrow should become the everyday rule and not the rare exception, as it was until recently. Unlimited opportunities must be opened up for capable and daring people.

Much has been omitted in the training, selection and placement of personnel. In conjunction with party committees, operational managers should carry out much serious work in this area. It cannot be permitted that labor

collectives--be they shops, wings, plant departments, bureaus or laboratories--are managed by incompetent people who have lost a sense of the new. The process is not a simple one, of course. But as soon as we stated that the main thing in restructuring is the activation of the human factor, we should be consistent.

In order to accelerate the creation and assimilation of new equipment and raise the rate of scientific and technical progress overall, especial concern for reinforcing the experimental test base should be manifested, as well as shops and services for preparing the production of new products, which at each plant, and I repeat, at each one, should total no less than 7-10 percent of productive capacity. Everyone speaks of these fundamental issues. They speak sharply, because the development of these services is clearly lagging.

Second--the party congress has posed the task that each association and enterprise, as well as each sector overall, develop prospective plans that go beyond the framework of the current five-year plan for the renewal of production using modern equipment and technology. In essence, the discussion concerns the fact that every labor collective have a clear picture of the future retooling of production equipment and technology, the improvement of industrial relations, transformations in the social sphere and the improvement of working conditions. Much socio-political work should be developed around this program. Lofty aims, understood by all, should uplift the masses and inspire them to intelligent labor. Leningraders have accumulated much experience in this area in the realization of the Intensification-90 program. Now it must be made concrete in the spirit of the times, taking into account the new tasks and looking further into the future.

Verification on the spot has shown that the program tasks placed before the machine builders for the 12th Five-Year Plan have not been developed into well-defined plans of action, and a group of measures providing for the fulfillment of five-year targets, not to mention the future, has not been supported at many enterprises, associations, scientific research institutes and design bureaus. These problems also exist at a number of Leningrad machine-building enterprises, even including in the practice of realizing the Intensification-90 programs developed earlier. The Central Committee has evaluated the activities of ministries on this account. Matters must be corrected more quickly, and the level of organization must be doubled and tripled.

Third--we link the more efficient utilization of existing potential with the processes of production renewal and the restructuring of the productive life of collectives. In local areas, one always sees 20- and 30-year-old machine tools standing alongside modern machining centers, even at the best enterprises, including Leningrad ones. At the same time, progressive types of equipment are in many cases utilized on one, sometimes incomplete, work shift.

The party has determined an approach to resolving this urgent problem. In May of this year, the CPSU Central Committee Politburo approved the initiative of the Leningrad Oblast party organization for a transition to two- and three-shift work modes. Many operational managers at Leningrad machine-building

enterprises have undertaken the matter well. Their example was actively followed by the people of Kharkov, Ulyanovsk and Belorussia.

Instances are known, however, that prove that some managers, and such exist in Leningrad, nonetheless are shaking things up, contriving things, and pondering which machine tools and where to put them. There is no time to lose for anyone. I say this because I am obliged to be completely aware that the task of organizing the transition to new working conditions can be realized effectively only on a regional basis in conjunction with the ministries. Operational managers, with the participation of party and soviet organs right on the spot, should take the organization of matters into their own hands.

Fourth--in resolving the main task of improving the existing productive potential, a course of investment policy for the preferential technical retooling and reconstruction of existing enterprises should be carried out unswervingly. It must be stated that from the point of view of the investments themselves, the matter does not look bad today, they are increasing, and their proportions in the majority of cases are approaching 50 percent. This is the correct approach.

What can restrain the execution of this important policy in practice? Resources of progressive equipment--here is where a bottleneck can form. Those who relied only on the centralized development of machine-tool building in the country and pushed aside the resolution the urgent problem of their own machine-tool building made a great mistake. In this area, every operational manager must reconstruct more quickly and energetically increase the capacity of the productive base for the manufacture of process equipment and other tooling with his own resources.

Another path is also important. One must be steadily occupied with the radical modernization of machine tools that are being dismantled in connection with the transition to two- and three-shift working conditions. Standard parts and assemblies can be manufactured on the basis of mutual cooperation. I am confident that such experience does not interest the Leningraders. Think seriously about this.

The future reconstruction and modernization of enterprises is indissolubly linked with the work of construction organizations. As is well known, today they are being decisively restructured. Radical reform is being realized in construction. The party is counting on the success of the matter. At the same time, under these conditions it is absolutely necessary to develop construction using the organization's own resources. The more so as material resources are now supplied to them for the level of capital construction. Not all have yet comprehended the importance of this way of increasing potential, but psychology absolutely must change herein as well.

The tasks of accelerating the development of machine building must be resolved comprehensively. I have social issues in mind. If the economic planner forgets the social sphere, it can be stated directly that disaster awaits him in production. None of the newest technologies and machining centers will rescue him. The development of the social sphere should occupy a suitable place in all operational and economic activity.

Fifth--an extremely important task--and this was especially emphasized at the party congress--is the execution in practice of the principles of genuine economic accountability, self-recoupment and self-financing, the incorporation of the collective contract not only in teams, but in larger production subdivisions, and the improvement of the mechanism of economic operations.

Well-known experience has already been accumulated in this, and the greatest value is presented by the practice of the AvtoVAZ Association and the Sumy Machine-Building Plant imeni M.V. Frunze. In the coming year, over 400 machine-building associations and enterprises will be operating under these management conditions. I am convinced, however, that there are still too few such enterprises in Leningrad.

The managers of associations and enterprises that are converting to the new conditions must take the situation in hand in each production collective--large and small--and themselves master the new economic approaches to organizing operational activity a little more deeply, directing the whole management apparatus toward this. Problems that arise must be studied thematically and they must be reacted to immediately, and the publicizing of results under the new economic operating conditions must be raised.

The work executed in the region on improving the organizational structure of management, the development of production and scientific production associations and the creation of intersectorial scientific and technical complexes and engineering centers is quite visible to you. Through these structures, the party and the Soviet government are striving to realize the advantages of the social system of economic operation. Therefore, the issue of creating all conditions for their vitality and high effectiveness is not only an economic, but a political issue. You can suggest much for its resolution. We await proposals from you.

Sixth--Recently the CPSU Central Committee Politburo adopted an important resolution on improving foreign economic activity. A number of ministries and, I especially want to emphasize, associations and enterprises were granted the right to direct access to the foreign market. In Leningrad, at the first stage, the Izhorskiy Plant, Leningrad Metallurgical Plant, Nevskiy Plant, Elektrosila and several other associations obtained this right.

I will state bluntly that this question has never been posed so boldly in all of our history. But its resolution requires non-standard approaches, completely new thinking and a deep psychological restructuring. Much must be learned here--the output of good and competitive machinery, how to trade, and the building of business relations with foreign partners.

The creation of a climate of creative incandescence in every collective of machine builders is the primary task today. Quality and reliability of machinery and machine tools of 90 percent, if not more, depends on the immediate executor, on what we call the human factor. We must proceed from this in arranging work at enterprises in all aspects.

From the Speeches of Conference Participants

Elektrosila Production Association imeni S.M. Kirov General Director B.I. Fomin: "The first proposal is, let's go ahead and experiment and, over the course of five years, say, let's stop introducing new standards and making changes in existing ones. With the exception of special cases.

"The next issue is, it is essential that enterprises obtain modern automated systems at the same time as control programs and software. This concerns both SAPRs and flexible production systems. Creating programs and software in-house is not the solution to the problem.

"And now the further development of capital construction. The time has come when the mutual responsibility of the customer and the contractor for overall capital investment is necessary.

"And further: today, in our opinion, there exists an unsuitable practice of equipment replacement. As soon as the enterprise installs new equipment using its own money, it has to pay two rubles for every ruble of installed equipment for increasing capacity. A number of enterprises are unwilling to proceed to technical retooling with regard to this.

A question from the floor: "And how should it be done?"

B.I. Fomin: "What is advantageous for production can be installed using one's own money. Whatever is obsolete should be written off a little faster. This procedure should be consolidated in the law on socialist enterprises--to have what is earned at one's disposal."

Leningrad Nevskiy Plant imeni V.I. Lenin Association General Director G.F. Velikanov: "Planning must be improved. I feel that the law on socialist enterprises should indicate that the plan targets, especially for product type, be delivered to production in a timely fashion, and not late, as happens today.

"More about planning. It seems we are trying to reduce the number of all types of indicators, but their number is still increasing. We plan with 300 of them, for example.

"And meanwhile, no matter what we say, we cannot get rid of the notorious planning in tons. The association has acquired a new metallurgical mill which produces blanks with exceptional precision. It is unsuitable, however, with such planning."

Elektronmash Scientific Production Association General Director P.I. Radchenko: "I think it is essential to make a more flexible policy in the realm of creating programs for machine tools with numerical control. I think an unjustifiably large number of programs are proposed. Their quantity must be reduced while quality is raised. I see that as the comprehensive resolution of this problem."

The conference participants expressed a whole series of proposals and desires aimed at the most rapid resolution of fundamental issues in accelerating the development of Soviet machine building. They concern practically all aspects of the work of enterprises and sectors.

Certain suggestions can be realized currently, while others require careful study. The chief thought that was expressed at the conference, however, is that Leningrad machine builders do not intend to sit with hands folded until favorable working conditions are created for them. The country needs improved equipment immediately, now, and the sense of the restructuring that is taking place in the sectors and enterprises is to achieve a sharp turn toward the better without delay, making full use of existing reserves, and to dispense with dependent inclinations, placidity and the emulation of obsolete prototypes. The party organizations of the city of Lenin are directing the labor collectives of all sectors of the machine-building complex precisely toward this.

Also participating in the conference was Yu.F. Solovyev, a candidate member of the CPSU Central Committee Politburo and first secretary of the Leningrad CPSU Obkom.

CPSU Central Committee Machine-Building Department Chief A.I. Volskiy, USSR Minister of Heavy and Transport Machine Building S.A. Afanasyev and key employees of a number of ministries and departments took part in the discussion of issues.

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INDUSTRY PLANNING AND ECONOMICS

MACHINE TOOL INDUSTRY ACHIEVEMENTS FOR SEPTEMBER 1986

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 12 Oct 86 p 1

[Article under the "TsSU SSSR [USSR Central Statistical Administration] Reports" rubric: "September Results"]

[Text] Industrial production volume in September increased by 5.6%, compared to the same month last year, whereas productivity increased by 5.3%. 96% of the increase in production was due to increased productivity.

In fuel and energy industries, increase in industrial production in September was equal to 4.3%. Gas industry had been expanding at the fastest pace. The monthly quota on gas production and coal mining and on electric power production were exceeded. The lag in oil producing industry is in the process of being overcome: oil-industry workers produced 0.2 million tons of oil (including gas condensate) above the quota. Production of oil, using new methods of attacking oil pool, increased.

Enterprises of metallurgical complex were operating at a stable rate. All in all, they fulfilled the plan both in increase in production and in manufacturing all types of metallurgical cycle products. However, they did not meet quota on expanding production of some progressive and economical types of metal products.

Machine building industries were expanding ahead of schedule. In September, their production increased by 7.8%, or 40% faster, than industry as a whole.

At the same time, some machine building Ministries allowed expansion pace to slow down, and their production increase in September was below the year quotas. Particularly, this is true for Mintyazhmash [Ministry of Heavy and Transport Machine Building], Minkhimmash [Ministry of Chemical and Petroleum Machine Building], Minstankoprom [Ministry of Machine Tool and Tool Building Industry].

Mintyazhmash enterprises did not meet the monthly quota on production of blast furnace and steelmaking equipment, freight and passenger rail cars, machines and equipment for continuous blank casting; Minkhimmash enterprises did not meet the quota on production of chemical equipment, and Minstankoprom enterprises did not meet the quota on production of press-forging machines (in

rubles). Also, quota were not met in production of a.c. electrical motors (Minelektrotekhprom [Ministry of Electrical Equipment Industry]), silage and fodder harvesting combines (Minzhivmash [Ministry of Machine Building for Animal Husbandry and Fodder Production]), production equipment for light industry, washers and refrigerators (Minlegpishchemash [Ministry of Machine Building for Light and Food Industry and Household Appliances]).

The lag in fulfilling production plan for a number of the most important types of products had also affected the status of contract discipline in shipment of products in the above mentioned Ministries.

Enterprises of the chemical and timber complex did not fulfill the sales plan. The most lagging are Minudobreniy [Ministry of Mineral Fertilizer Production] enterprises: in September, the overall sales plan was only fulfilled by 97%. Chemists did not fulfill production plans for such profile types of products as mineral fertilizers, chemical means for vegetation protection, synthetic resins and plastics, as well as a number of raw material products, such as synthetic ammonia, sulfuric acid, soda ash and caustic soda.

In September, Minlesbumprom [Ministry of Timber, Pulp and Paper, and Wood Processing Industry]) enterprises improved their overall status, but they still lag in meeting monthly quota on production of merchantable wood, lumber and fiber board.

Minlegprom SSSR [USSR Ministry of Light Industry] has met quota on production of the majority of products. However, it did not assure meeting the plan on production of silk cloth, underwear knitting goods and footwear.

12770

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MACHINE BUILDING KEY TO ACCELERATION

Moscow KRASNAYA ZVEZDA in Russian 28 Sep 86 p 1

[Article by S. Ovsienko: "The Key to Accelerating Growth"]

[Text] Machine building in the USSR now has great scientific and technical potential that has become the key to accelerating economic growth. During the 12th Five-Year Plan, fixed production capital grew by a factor of 1.5 in the machine building industry. In the same period of time, personnel at both research and design organizations developed more than 19,000 new machines, pieces of equipment, devices, and instruments that are now in production in USSR manufacturing facilities. Products made at such associations as the ZIL [Moscow Automobile Plant imeni Ligachev in Gorky], AvtoVAZ [Volga Automobile Plant imeni 50th Anniversary of the USSR in Togliatti], Elektrosila [Electric Power Association], Uralmash [Urals Heavy Machine Building Plant imeni Sergo Ordzhonikidze in Sverdlovsk], and the MPO [unknown] imeni M.V. Frunze in Sumsk are among the best in the world.

Nonetheless, many of our machines are not up to the standards of other countries. Examples of such machines are forging and stamping equipment and internal combustion engines. At many machine building enterprises, insufficient use is made of high output equipment, and non-waste technologies have not been introduced at an appropriate level.

The June (1986) plenum of the CPSU Central Committee noted that we will not be able to accomplish the goals specified by the 23rd Party Congress unless the machine building industry is quickly modernized and reorganized to enable it to produce new machine systems and sophisticated equipment for all sectors of the economy. These goals include accelerating scientific and technical progress on a broad scale and fundamentally changing the productive forces in our society.

The resolutions pertaining to this issue and adopted by the party contain concrete measures to accelerate the development of the machine building industry. A USSR Council of Ministers Buro in charge of machine building has been created. The job of this organization will be to ensure competent management of the industries in the machine building complex. Tasks which must be performed quickly include developing the tool building and electronics industries and increasing output of computer hardware

and instruments. And the job of making sure products are up to date and of high quality is also more critical than ever. The frequency with which machinery has to be updated is growing. Thus, while it used to be necessary to update machinery only once every 32 years, by 1990 updating will be required every 7 to 7.5 years.

Microelectronics has created fundamentally new ways to automate the operation of machinery and improve performance. Plans for the future include using microprocessor control devices to raise reliability by a factor of in the 3 to 5 range in the instrument, tool, and electrical equipment building industries and to reduce automobile and agricultural machine building industry fuel consumption by 10 to 20 percent. Output of microprocessor-based computer complexes and personal computers will increase by a factor of 1.8.

The five-year plan is forging ahead. So today, the most important thing for those involved in the machine building industry is to pick up the pace of progress with no further ado.

13189

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INDUSTRY PLANNING AND ECONOMICS

MEETING ON HIGH OUTPUT, RESOURCE-CONSERVING TECHNOLOGIES

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 4 Nov 86 p 2

[Article by I. Glyanko, "Pravda Ukrainy" correspondent, from Chernigovskaya Oblast: "From Idea to Reality"]

[Text] A joint meeting of the Ukrainian SSR Academy of Sciences' North-West Scientific Center Council and the Chernigovsky Oblast Scientific Coordination Council has taken place in Chernigov. The scientists and industrial personnel at the meeting focused their discussion on introducing high-output resource-conserving technologies and equipment.

Considerable progress in this direction has been made at Chernogovshchina. Non-waste methods of cutting materials have been employed more extensively, and oil, wood, and other resource materials are processed more completely. In the machine building industry, excellent results have been obtained by replacing traditional cutting-oriented metal-working techniques with more advanced low-waste methods, including forging, precision casting, casting under pressure, rolled forming of parts, electric arc welding, etc.

Over the last five years, these and other techniques have resulted in savings of 33,000 tons of rolled ferrous metal, 32,000 tons of cement, 92,000 cubic meters of wood, 148,000 tons of furnace and hearth fuel, 194 million kilowatt-hours of electrical energy, and 29,000 tons of gasoline.

However, there is still room for improvement in the area of resource conservation. By way of illustration, we need only mention that fuel, materials, and energy account for 82 percent of the cost of producing an item in the Chernigovsky area, while this figure for the country as a whole is 75 percent. For light industry in the area, this figure is even higher: 94 percent. Insufficient use is made of waste products from leather, sugar, and metal working facilities, and TES [Thermal Power Stations] fuel by-products.

According to Ukrainian SSR Academy of Sciences academician G.S. Pisarenko, chairman of the North-West Scientific Center "We need to have closer ties between science and industry if we are

to solve these problems; and we need to make sure that scientific ideas pass from inception to widely used industrial reality in a clear cut expeditious manner."

At plenary and group sessions, speakers noted that if machine building and other industries begin using thermal gas, ion plasma, and electric arc techniques of applying protective and reinforcing coatings, metal and alloying materials will be able to be conserved and the better materials needed for today's operating conditions will be available. Areas which received attention included the use of surfacing to produce and repair parts that wear out quickly and the employment on a broader scale of technology and equipment using liquid metal to restore tractor support rollers. Also mentioned was the idea that developing and introducing high-output combined cultivators, subsurface cultivators, subsoil rippers, and deep rippers will result in increased labor productivity, reduced fuel consumption and metal usage, and less field dockage.

After the above discussion, the members of the two organizations attending the meeting visited a technical idea fair, where seven exhibits were demonstrated. The exhibits were organized by personnel from the USSR VDNKh [Exhibition of Economic Progress], academic and industry-affiliated institutes in the republic, and the All-union Livestock and Feed Production Machinery and Equipment Testing Research Institute.

As V.A. Kharchenko, secretary of the Chernigovsky party obkom, stated, "This technical idea fair is designed to help speed the pace at which science, technology, and advanced know-how are incorporated into industry; it will also improve coordination between scientists and specialists, academic and industry-affiliated institutes, and engineering design offices and enterprise technical councils. At factories and plants, we will have "specialist days," at which we will discuss everything we have seen here and make concrete plans to use appropriate ideas encountered here. And we are going to declare next year the "year of review of incorporated innovations," over the course of which we will be reviewing innovations from the idea market."

The scientists from academic and industry-affiliated research institutes visited 20 enterprises in the oblast, studied manufacturing processes, made technical recommendations to workers' collectives, and concluded agreements with them to work together to introduce new high-output resource-conserving technologies and equipment.

13189

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ENGINEERS DISCUSS NEW DOCUMENTATION PROCEDURES

Moscow STROITELNAYA GAZETA in Russian 12 Nov 86 p 4

[Article by A. Semenov: "Engineers Council"]

[Text] A regular session of the Council of Chief Engineers from the major machine building enterprises was held at the State Standards Committee. Participants discussed findings pertaining to work done since implementation of the new procedures for writing and coordinating technical documentation. The new procedures became effective on Feb 1 of this year.

Members of the council noted that reforms aimed at simplifying technical documentation writing procedures have been effective. However, there are still many people who have not made use of the independence these reforms entail. Indeed, although the simplified procedures have given engineers more independence, it would appear they have also given them more responsibility. There was nothing more reassuring in the old days than the knowledge that individual responsibility would be eroded away by floods of paperwork. For this reason, the council made it perfectly clear that stepping up efforts to ensure compliance with new procedures was a priority.

Everyone agreed with the thesis that merely simplifying the procedure for writing and coordinating technical documentation is not enough to ensure that new machinery goes into production. One item on the agenda is to match the planning of the production line which will be producing an article with the actual production environment.

This is already being done. Tool building personnel in Ivanov have shown that a considerable amount of time can be saved if product development and production process planning are accomplished in tandem. In Ivanov, the production line is readied at the same time engineering documentation is being written and prototypes are being worked on.

B. Sokolov, chairman of the Council of Chief Engineers and first deputy chairman of the State Standards Committee spoke about a fundamental change; that is, that the designer of a product has

the right to independently determine the number, type, and other details of the tests of any new model of a product or of any of its parts or components. Of course the risk involved here must be commensurate with the potential losses that one or another design changes may entail, an issue which modern science, which has reached a point at which it is possible to forecast what these potential losses may be, can resolve. Naturally, obtaining the best in experimental and testing equipment is a key item. Moreover, we will have to acquire the latest in modern modelling know-how, particularly mathematical modelling.

Changes to the keystone GOST [State All-Union Standard], which becomes effective on 1 Jan 1987, have already been made. These changes permit stages of development to be combined, free designers from mandatory preliminary tests, and allow testing of individual components of a unit.

During the session, the members of the council noted that normally the person or agency ordering a product informs the designer of his requirements, and that the engineer then regards these requirements as law. Is it not time for us to put the engineer on a superior footing to the designer? The engineer should be telling the designer what the latter needs to do to make sure his plan is up to world technical standards.

The following took part in the meeting of the Council of Chief Engineers: I. Silaev, deputy chairman of the USSR Council of Ministers and chairman of the USSR Council of Ministers Machine Building Buro; and G. Kolmogorov, chairman of the State Standards Committee.

13189

CSO: 1823/49

INDUSTRY PLANNING AND ECONOMICS

BSSR MACHINE TOOL INDUSTRY LAGGING, DEFECTS CRITICIZED

Minsk SOVETSKAYA BELOROSSIYA in Russian 27 Oct 86 p 2

[Editorial: "In the BSSR Committee of People's Control"]

[Text] The regular meeting of the BSSR Committee of People's Control (KNK) considered the question of product technological standards and quality at several USSR Ministry of the Machine Tool and Tool Building Industry enterprises located in our republic. A number of serious omissions were uncovered.

Let us take the Pinsk Forging-Pressing Machine and Automated Foundry Line Production Association as an example. Process and manufacturing discipline is low here. Not one of the 30 production processes selected for testing was in compliance and not one component was in accordance with its plans. The technical monitoring department rejects more than 10 thousand components each day. Technical documentation reaches the production departments with serious errors. Performance monitoring of the most critical operations is extremely poor. Testing schedules are not fulfilled. Only 153 of the 234 operations scheduled to be monitored during the first six months of this year were actually checked, even then only 10 of these were plan operations.

The enterprise does not have an adequate number of measurement, testing and monitoring devices. They are short 6500 clearance gages, feeler gages and inside calipers, etc. A number of parameters (noise and temperature level, etc.) are only measured on final products. This causes additional labor requirements for unit adjustment. Press gear pair rolling takes place under no-load conditions. Hydraulic cylinder testing is confined to a seal test.

Manufacturing conditions are poor. The existing equipment is not being maintained properly. Components are piled everywhere, chips are not cleared away in a timely manner and scrap is not being removed. Units and components are dirty, nicked and scratched when they reach the assembly area and they are not washed or cleaned. There is no special equipment for conveying these items.

A lack of activity on the part of the responsible services was the main reason for the production of defective items. In the last year and the first half of this year 500 thousand rubles of claims have been made against products,

Gosstandart sanctions totalling more than one million rubles have been applied and 114 thousand rubles of revenue have been lost. The production of presses urgently needed for calibrating metallic powder products has been stopped due to a low standard of technology and unsatisfactory quality. Even the simplest items such as electroplating vats, fodder steamers and children's rakes have an unattractive appearance.

The ministry's requirements for manufacturing the highest quality products are not being fulfilled. In the period between January and June these products made up only 21.3% of the total production volume--half the sector average. Of the 20 products subject to certification named only three were awarded the Seal of Quality.

The situation is no better at the Volkovysk Foundry Equipment Plant. Its managers have not taken any effective steps toward fundamentally increasing product quality and technological standards. Here 15-25 year old foreign machinery serves as the standard. As an example, the license for a molding form mixer that was brought on-line last year was purchased in 1972. Similarly, the facility's friction welders are foreign models produced in 1960. The modernization of final products carried out was ineffective. Their basic operational characteristics were not improved and in some cases they were even reduced. Product reliability is not being evaluated.

The most important production processes are not monitored. Less than 0.5% of all operations are checked each year. Rejection losses are not being reduced.

The highest category certification schedule was disrupted by two machine models last year and by three models this year. Production of four new products scheduled for introduction in the first six months of this year was not started. The proportion of uncertified products is high; rising from 11% in 1980 to 40% this year. The product acceptance sequence has been disrupted and not all products are being tested.

Serious deficiencies were revealed by an examination of the Grondnenskiy Lathe Chuck Plant. Gosstandart agencies stopped product shipments last year and applied an economic sanction this year. The reason? Low manufacturing and process discipline and unsatisfactory efforts on the part of the technical monitoring department. The department's workers are resigned to the situation and are fully aware that they are putting unsatisfactory products on the market. In a period of only two months this year more than 200 thousand rubles of these lathe chucks have been sent to customers.

Product acceptance tests are carried out on uncertified equipment and the results are unreliable. The reverse cams fitted to the enterprise's lathe chucks are not graded. This leads to inadvertent switching and reduces product accuracy.

The first decade of operation found product output at 8-20% of monthly norms at the Volkovysk plant, while that of the Pinsk association was 60-75% of the monthly standard. Machine tool accuracy standards are not being certified. The offices of the chief production engineer and metrologist are allowing matters to proceed on their own. Chips and dirt are not being cleaned from machines at

the Pinsk association and at the lath chuck plant. A significant part of the Volkovysk plant's equipment is physically worn and obsolete; nearly 62% has been in operation for more than 10 years and 26% of these units have been working for over 20 years.

Preparation for work station certification is especially unsatisfactory. The majority of basic technological requirements are not being met at almost all of the enterprises examined.

Lethargy in these matters is also being tolerated at the Minsk and Baranovichi automated lines plants.

V. P. Rakhin, chief engineer of the Pinsk Forging-Pressing Machine and Foundry Equipment Production Association, was terminated as a result of a decision by the BSSR KNK to seriously pursue solutions to problems of improving product quality. The chief engineer of the Volkovysk Foundry Equipment Plant, Ye. A. Bogatyrev, received a severe reprimand and the head of the Grondnenskiy Lathe Chuck Plant's technical monitoring department, A. F. Sabitov, received a reprimand. Comrade Sabitov also received a fine of one month's salary.

The deputy director of the Pinsk Forging-Pressing Machine and Foundry Production Association, A. I. Sidorovich, deserved severe punishment but the committee considered the brief period of his employment and reprimanded him.

Consideration was given to the fact that the BSSR KNK's Machine Building and Chemical Industry Department had heard the explanations of inadequacies in the organization of labor for a fundamental increase in product technology level and quality given by the managers of the Minsk and Baranovichi automated lines plants and had accepted their assertions that the inadequacies would be eliminated immediately.

12746

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INDUSTRY PLANNING AND ECONOMICS

SUPPLY, DELIVERY ISSUES IN MACHINE BUILDING DISCUSSED

Moscow IZVESTIYA in Russian 3 Nov 86 p 2

[Article by R. Lynev: "Before the Session of the USSR Supreme Soviet: ... With Amendments and Supplements"]

[Text] During this five-year plan machine building must develop more rapidly than any other branch and set the pace for other branches. Judging by the recent meeting of the USSR Central Statistical Administration which reviewed the nation's socioeconomic development, that is just what is happening today.

The recent meeting of the USSR Supreme Soviet's Machine Building Preparatory Commission discussed the state of affairs in the machine building complex and plans for the coming year in more detail. Its members--deputies of this major organ of state power--heard reports prepared by Gosplan, Gossnab, the State Committee for Science and Technology (GKNT), the USSR Ministry of Finance and leaders from all 11 machine building ministries. These members also expressed their own suggestions and observations.

The ministry leaders told of achievements by their branches at the outset of the five-year plan and discussed as yet untapped resources for accelerating development. The picture was substantially supplemented by the deputies who spoke after the ministry leaders. This was especially true in the case of resources. As an example, the Minister of Heavy and Transport Machine Building, S. Afanasyev, began by saying that branch enterprises and associations were successfully coping with their assignments according to all basic indicators and that new economic conditions were reflected.

Speaking next, commission member A. Aleksandrov, a deputy who works as a thread grinder at the Cheboksary Machine Building Plant, confirmed that this was all true. But what kind of indicators are these basic ones. They are primarily quantitative indicators of volume on which the entire scope of the sector "operates." While these indicators suit the purposes of the manufacturer as revenues rise with them, they have yet to produce any great benefit to consumers, meaning enterprises in other sectors and therefore the national economy as a whole. Unfortunately, one indicator which is very important to the consumer, fulfillment of the contract delivery plan, is only improving slowly. Not one of the complex's branches has achieved 100 percent yet. Who isn't just two percent short of the plan and who is only a few dozen

points off? These are just small amounts. When translated into monetary terms, however, they become tens of millions of rubles. In nine months the product shortfall at the Ministry of Instrument Making, Automation Equipment and Control Systems enterprises and associations was 50 million rubles. Similarly, the figures are 40 million rubles at the Ministry of Construction, Road and Municipal Machine Building; 99 million in petroleum and chemical machine building and 44 million in tractor and agricultural machine building. These numbers are not just money, they represent the cost of products which are often the most complex and labor-intensive and which, while not always profitable to the manufacturers, are at times most urgently needed by the consumer.

All these delivery failures are extremely perceptible to the specific consuming enterprises but do not have much impact at the level of the producing branch. This once again leads to the thought that the restructuring has affected only the upper layers of economics and not yet penetrated to the depths where the most important of today's indicators--the qualitative ones--are found. These indicators include quality, technical standard and the pace of product line and basic production asset renewal. They encompass production, the fundamental consumer good product lines and expansion of monetary rewards to the population.

"When will the local truck and car spare parts demand finally be satisfied?", commission member deputies asked the USSR Deputy Minister of the Automotive Industry, M. Pogostinskiy. He explained that expenditures for spare parts now amounted to 2.226 billion rubles, a level not found anywhere abroad.

"But the demand for spare parts," he explained to the deputies, "is not generated by the consumer, in a manner of speaking it is built into the vehicle and depends primarily on the quality of manufacture."

The question raised by the commission was as follows: do robotized complexes, machining center-type machine tools and automated and semi-automated lines capable of increasing labor productivity by 1.3 to 1.5-fold, as V. Kedrov, deputy minister of machine tool building, emphasized, actually provide quality if their level of technology, reliability and durability are low? Isn't that why production personnel do not have great faith in them?

"At first I didn't believe," said the Izmash Association's chief designer, Deputy M. Kalashnikov, "but after examining it I was convinced: the full operating time of lathe modules produced by the Moscow Red Proletariat Association, the manufacturer of more than 40 percent of these units in this country, is 30 hours instead of 400."

A stream of defective products passes from manufacturers to consumers, causing malfunctions, interruptions and extraordinary production expenses.

"An investigation conducted by the USSR Committee of People's Control in May of this year," said Deputy G. Oganyan, first secretary of the Armenian Communist Party's Kirovakan Gorkom, "revealed serious shortcomings in the quality of tractors produced by the Kharkov Tractor Plant." It was determined that association management misrepresented actual product quality and failed

to report the true number of claims presented. Thus, kolkhoz and sovkhoz data show that 5500 tractors broke down last year while the Kharkov Tractor Plant reported receiving only 381 claims.

In instrument making, which is as Deputy V. Faustov, general director of the KamAZ Association, noted, "the branch called upon to set the quality standard for others," USSR State Committee for Standards enterprises stopped product output 198 times. In 24 cases the prohibition involved the issuance of design documentation.

Almost all ministry representatives spoke to the commission with great hope concerning the shift of a significant portion of enterprises to state product review at the start of 1987. Time will tell how justified these hopes are. However, G. Stroganov, a USSR Gosplan deputy chairman, said that at this time inspectors have only half of the monitoring and measurement equipment they need.

Commission member deputies questioned A. Kamenev, deputy chairman of the USSR GKNT, about problems of quality and the standard of technology in machine building products. Why, they asked, has the quality indicator been more or less split recently? On one hand, reliability is considered the criterion for awarding the State Seal of Quality. On the other hand the plan includes a product's status in terms of the worldwide technology standard as an indicator. What is the reason for this second indicator and how does it relate to the first? How can you measure up to a worldwide standard if it moves or has changed? Can't the pursuit of today's standard result in being behind tomorrow's level?

A. Kamenev answered, "The developers themselves must ensure that the technology of innovations is in accordance with worldwide standards. The GKNT only confirms the data from developers by means of expert testing." This answer didn't satisfy the deputies. It was unsatisfactory because the GKNT is only capable of testing a small portion of the innovations specified in the new equipment plan. Evaluation of the rest of the innovations will mostly be in the hands of the developers themselves, an unreliable criterion from the consumer's point of view.

The point of disagreement with A. Kamenev lies in the fact that competition with the best worldwide achievements will become only a desire unless the branches have in-depth scientific efforts and their own experimental facilities with test stands capable of developing parameters such as quality, reliability and durability. Considering this, the branches received a recommendation that they direct from 8-12 percent of their capital expenditures allocated for development to the creation of scientific, testing and design facilities. This would seem to provide the possibility of a major step toward scientific and technological progress. But what did the branches do? The ministries of Heavy and Transport Machine Building and of Machine Building for Animal Husbandry and Fodder Production allocated not 8 but 7.4 percent of their capital investment to this important area. The numbers for the Ministry of Machine Tool and Tool Building and the Ministry of the Automotive Industry were 7.3 and 6.1 percent respectively. As we can see, the old tendency of sacrificing everything, including science, for the sake of

production is still alive. It is as if the experience of past years has not taught us that savings on science and its experimental facilities become a brake on production and cause it to stagnate and fall behind.

A number of sectors have come to understand another important change in the capital investment structure: the redirection of 10 percent of resources from production to housing construction, social and cultural projects and preschool facilities. But, in addition to the fact that these facilities are being built at a pace slower than that of production facilities, the leaders in some sectors feel that the government should "reimburse" them for these capital outlays "torn away" from production.

There are still two important situations which illustrate the level of economic work in the machine building branches and which the representatives of these branches are either trying to avoid or to paint in the most general terms.

So, emphasizing that the plan's draft still has not been completely reconciled with the supply of materials and equipment, ministry representatives classified the amount of rolled metal product and plastics shortfall, which again has a significant effect on product quality, under the technological standard indicator. Was the reproach of Gosplan, Gossnab and the USSR ministries of Ferrous Metallurgy and the Chemical Industry justified? Of course. The commission recommended that this problem be solved. There is still time.

Here is a different set of facts: 27 percent of the metal, or 12 million tons, now goes into byproducts. The rolled metal product scrap total was 2.1 million tons at the start of the year and it grew to 2.3 million tons in six months. At this rate of usage there will never be enough metal.

Next the deputies emphasized in their presentations that any evaluation of branch operations must not cover just the revenues received but the entire picture of financial activity, including the status of floating capital, penalties for failure to deliver and rejected products and bank debt due to credits not retired on time.

It is no accident that, in analyzing the results of branch operations, the deputies did not confine their examination to production and technology but directed more attention to economics, which shows what was achieved and at what cost. The relationship of revenues to expenditures in an important aspect of the new style of operation. Machine builders are called upon not only to lift the level of technology in the national economy but also to set the tone for the restructuring of economics.

12746

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RE-EQUIPPING BLANK MANUFACTURING IN MACHINE BUILDING

Kiev TEKHNLOGIYA I ORGANIZATSIYA PROIZVODSTVA in Russian No 4, Apr 86 p 5-6

[Article by L.F. Krayev, candidate of economic sciences]

[Text] The task of economically utilizing material, fuel and energy resources set forth by the party and government is especially critical to the machine building industry because expenditures for materials average 75% of the sector's product costs while energy expenditures are 12% of these costs. Nearly 80% of these amounts are spent on the production of blanks, a metal- and energy-intensive manufacturing process.

Thus, the UkSSR machine building industry's metal usage coefficient in pressure working during 1985 was 0.48-0.82, with 1138 kg of rolled stock, 1543 kg of ingot material and 1199 kg of stamped forgings going into each ton of usable forgings. The ratio of blank mass to final product mass was 0.3 (ingots), 0.5 (rolled stock), 0.7 (hot die forging) and 0.89 (precision die forging). Up to 10% of the rolled metal used in press forging is wasted. Metal chip loss in mechanical blank machining is 15-22% and it is estimated that 80-100 kW/h of electrical energy are wasted per ton of chips.

The republic's foundry output per usable casting in 1985 was 74% for cast iron, 59.5% for steel and 61.3% for nonferrous metal. The relative proportion of precision casting is low. Material usage is reduced when the casting production process is intensified. Accelerating the form drying process from 21 hours to 16 hours (based on one delivery lot) saves 345 kg of steam, 16 kW/h of electricity and reduces casting rejection from 32.5 to 8.6%.

An accelerated pace of re-equipment on the basis of new technology and organizational methods using achievements of scientific and technological progress is needed to reduce material and energy consumption in blank production. There is also a need for widespread introduction of progressive, low-waste and waste-free resource-sparing technologies, NC machine tools and automatic rotary and conveyor lines.

The use of powder metallurgy methods is efficient. This can enable a savings of up to 2.5 tons of rolled material per ton of sintered material. These components have a service life twice that of conventional ones. The metal usage coefficient is 0.98. However, at this time the use of sintered materials

in machines and equipment is low because the ferrous and nonferrous metallurgy industries are producing limited quantities of low quality powders. Furthermore, production capacity is not adequate to produce an increase in sintered blank production volume.

Significant resource savings are achieved when conventional materials are replaced with polymers. The production of one ton of plastic components allows a 3.5-ton savings in metal and produces a national economic effect of up to 1150 rubles.

The creation in existing manufacturing operations of specialized production facilities with an optimum capacity for producing blanks for use throughout the machine building industry has an impact on the national economy. This requires process specialization according to design characteristics and blank weight, as well as by type of production (mass, large-scale, series and small-scale). These specialized blank production facilities must be dedicated to satisfying this need in all industrial sectors within a given region. This would reduce conflicting shipments by establishing cooperation in blank deliveries, free a large amount of rolling stock turnover, lower shipping costs and save material, fuel, energy and other resources on a nationwide scale.

The task of establishing an integrated system for controlling material resources at all planning and control levels is becoming critical. Application of such a system would permit the use of huge reserves which can be sought by increasing individual machine and equipment item capacity, increasing new equipment productivity and operational reliability while reducing unit weight and dimensions, reducing energy consumption and materials usage per unit of capacity through the rational selection of construction materials, reducing the surplus capacity of units, components and modules to an optimum level through the use of computers in engineering estimates, making widespread use of resource-sparing technologies, reducing machining tolerances throughout the manufacturing process, using optimized methods for cutting rolled metal products, recycling by-products, using new material, fuel and energy consumption standards based on improved quota-setting techniques, eliminating material losses in transport, warehousing and stockpiling, using by-products and developing greater involvement in the process of producing secondary resources.

Material resource planning should be based on generalized indicators of utilization efficiency per final product unit. For example, machine building interests should plan the use of rolled metal product per ruble of commercial production, the proportion of new materials manufacture and energy-saving types of processes in terms of overall production and the specific consumption of materials, fuel and energy per capacity unit or a similar parameter. They should also establish indicators of commercial production fuel and energy needs which would permit more in-depth analysis of sector and enterprise operations as well as stimulate the introduction of scientific and technological advances.

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12746

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WORK STATION RATIONALIZATION IN MACHINE BUILDING ENTERPRISES

Kiev TEKHNLOGIYA I ORGANIZATSIYA PROIZVODSTVA in Russian No 4, Apr 86 p 12-14

[Article by Ye. I. Marchenko, candidate of economic sciences, and Yu. F. Panov, candidate of technical sciences]

[Text] The rationalization of work stations (RRM) on the basis of their certification is one means of increasing equipment utilization efficiency. Vinnitskaya Oblast machine building and instrument making plants have gained positive experience in work station rationalization. Work station rationalization and certification (ARRM) at the Mogilev-Podolskiy Machine Building Plant imeni S.M. Kirov is solving the pressing task of increasing equipment load factors. This work is tightly linked with the re-equipping of production and the improvement of labor organization based on scientific principles.

The enterprise has devoted a great deal of attention to introducing the brigade form of labor organization which in 1985 encompassed 74% of its workers. Earnings according to a labor participation coefficient were distributed to 98% of brigade workers. In 1985 introduction of the brigade type of labor organization permitted the release of 12 persons and provided an economic impact of 25,800 rubles. The organization of brigades with a standardized salary fund allowed the release of 40 workers and a salary fund savings of 33,600 rubles.

The introduction of multiple machine tool servicing and expansion of the scope of servicing in Shop No. 4 alone released 6 persons and provided an economic impact of 15,900 rubles. In all there are 78 multiple-machine operators in the shop and 91 workers combine duties. The use of these progressive forms of labor organization has released 13 persons.

The plant's scientific organization of labor and chief production engineer's services are developing labor organization charts for workers, engineering/technical personnel and clerical staff using progressive labor methods and techniques. Organization of engineering, technical and clerical personnel work stations according to these charts allowed the release of 15 persons and provided an economic impact of 15,900 rubles in 1985. Introduction of work station rationalization and certification measures in 1983-1985 took 155 physically worn and obsolete equipment units out of operation, reduced 21

work stations and freed 264.5 square meters of production space. One hundred work stations were rationalized in 1985, freeing 311 persons, producing an economic impact of 384,500 rubles and increasing labor productivity by 10.5%.

The implementation of a set of work station rationalization and certification measures brought about an increase in fundamental production technical and economic indicators. Specifically, the equipment shift utilization coefficient rose 2.8-4.2% in individual shops and the overall plant coefficient in 1985 was 1.72.

Return on investment is the universal indicator of machine and equipment utilization efficiency. Work station rationalization and certification is increasing this indicator by reducing basic asset costs and increasing production output as a result of eliminating low-efficiency work stations and creating high-efficiency ones. Calculations performed according to a special method indicate that work station rationalization and certification at the Mogilev-Podolskiy Machine Building Plant imeni S.M. Kirov increased the return on investment by more than 12% in 1985.

The rationalization and certification of work stations is a labor-intensive process. To reduce the amount of labor involved, one of the region's machine building plants has developed and introduced an automated work station certification system (ASARM) which supports the collection, evaluation, processing and storage of needed information. The latter capacity significantly exceeds that provided for in automated work station (ARM) instructions. As an example, a computer is used to formulate a consolidated accounting and automated work station listing, a plan for implementing measures to increase the organizational and equipment level of work stations undergoing rationalization and a plan for eliminating inefficient work stations, etc. In 1985, ASARM introduction provided a savings of 3800 hours of engineering work. Analysis of all the information provided by the ASARM allows the forecasting of an optimum number of work stations for the plant and the organizational and equipment level needed. This information can then be used as the basis for developing and implementing measures to increase these values.

The Terminal Production Association views work station rationalization and certification as a powerful tool for accelerating scientific and technological progress as the basis for increasing labor productivity and equipment/material resource utilization efficiency. Work station rationalization and certification has been in effect at the association since 1980. The initial stage involved the development and introduction of organizational and equipment measures to bring work stations in line with the requirements of standardized designs. Beginning in 1984, work station rationalization and certification measures considered not only the raising of work stations to the required standard level but a change in the equipment, technology, organization and even the psychology involved in the approach to seeking means of raising the efficiency of equipment and other resource utilization. ARMs are helping to create better working conditions which in turn enable workers to attain maximum productivity.

Having improved the work station rationalization and certification system in effect at the association by means of the experience gained by the Dnepropetrovsk Combine Plant imeni K. Ye. Vorshilov Production Association (recognized by the CPSU Central Committee), the collective moved on to overall certification. The task was to bring level of work station equipment and organization up to the worldwide standard. To achieve this, an "idea bank" for production equipment refitting was created and cooperation was intensified between the association and scientific organizations in order to seek new solutions in the areas of equipment, technology and production organization.

The creative search and initiative of the association's entire collective in carrying out work station rationalization and certification are supported through extensive application of various methods of organizing and stimulating this work.

During 1984-1985, work station rationalization and certification at the Terminal Production Association eliminated 187 work stations and freed 370 persons. In 1985 the coefficient of equipment shift utilization in basic production increased by 6% in comparison to 1984 while the return on investment grew by 7.4%. The economic impact was 1.37 million rubles.

More than 250 measures directed at increasing the technical level of production and production output were carried out during the 11th Five-Year Plan. The total economic effect was 5.5 million rubles and 1322 workers were released. At the present time two shops and five association sections have undergone complete mechanization and six mechanized and automated lines have been introduced along with more than 150 robots/manipulators and robotized manufacturing complexes, 29 NC machine tools and 51 computer complexes to automate the control of production, production processes and mechanize and automate engineering work. The proportion of workers involved in manual labor has been reduced to 20.6%.

Scientific/engineering and clerical personnel work station rationalization and certification is underway. Fifteen automated design systems have been introduced, reducing the number of scientific/engineering personnel, and increasing the volume of pre-production engineering work for new products more than 3.5-fold.

The entire production capacity increase was attained solely through re-equipment.

The positive experience of pioneering Vinnitsk Oblast enterprises in using work station rationalization and automation to increase equipment utilization efficiency can be useful in all the republic's production collectives.

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INDUSTRY PLANNING AND ECONOMICS

ECONOMIC FACTORS IN INTRODUCTION OF NC, FMS SYSTEMS

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[Article by G. D. Grigoryan: "Economic Problems in Evaluating Process Systems in Machine Building"; material in all capital letters in boldface type in original]

[Excerpt] The article is devoted to the topical problem of evaluating process systems used in modern machine building. It is noted that in evaluating planned process systems, it is essential to take into account the expedient allocation of expenditures between the spheres of production and operation of process systems, the size of profits that should be achieved in system operation and the time period for its utilization, system reliability and flexibility, the maximum utilization of design capabilities etc.

The evaluation methods described can also be employed to determine the development trends of process systems in machine building under conditions of an intensification of social production with limited expenditures of resources.

One of the most important tasks of the 12th Five-Year Plan, as noted in the Fundamental Areas of Economic and Social Development of the USSR for 1986-90 and for the Period to the Year 2000, is the shifting of the economy onto a principally intensive development path.

The intensification of production with a limited expenditure of resources brings to the forefront the need for the complete and immediate utilization of qualitative factors of economic growth, and especially the maximum utilization of the design capabilities of process systems in operation.

The fulfillment of the tasks projected in the Fundamental Areas by the machine-building complex should ensure a radical improvement in the structure of process systems, an increase in their technical level and, on that basis, the incorporation of progressive technologies into industry.

For the efficient technical retooling of industry, the resolution of such tasks as raising the level of automation, converting from the output of uncoordinated equipment to the manufacture of process systems according to the technical requirements of consumers for the complete machining of crucial parts, improving metalworking tools, supplying process systems by constituent elements etc. is essential. In other words, the quality and reliability of the technical portion of process systems should guarantee the manufacture of parts of the required quality.

The evaluation of planned process systems, in view of their complexity, generates a series of problems of an economic nature.

Expenditures for the manufacture and operation of a process system should provide for the requisite profit over the established life cycle of the system. The total expenditures of process systems should be allocated between the spheres of production and operation in such a way that the greatest socio-economic effect is obtained through increases in system quality and reliability and the economy of human labor.

A comprehensive resolution of the problem ensures a well-founded and optimal evaluation of process systems planned and used in machine building.

This problem is broken up into four subproblems: 1--the allocation of total expenditures between the spheres of process-system production and operation based on the requirements for freeing up manpower; 2--a determination of the optimal reliability of process systems; 3--a determination of expenditures for the manufacture of process systems depending on their reliability and the effect of system functioning over its life cycle as established by the requirements; and, 4--planning process systems taking into account the maximum utilization of their capabilities.

We will consider them in more detail.

ALLOCATING TOTAL EXPENDITURES BETWEEN THE SPHERES OF PRODUCTION AND OPERATION FOR PROCESS SYSTEMS BASED ON REQUIREMENTS FOR FREEING UP MANPOWER. Implementing a technological process is a task with two aspects consisting of the production of articles that satisfy the needs of the national economy with the minimum possible expenditure of social labor.

One of the most important socio-economic tasks is the economy of human labor, that is, freeing it up through growth in the productivity of the social labor of manpower employed both in the sphere of immediate production and in the sphere of process-system operation. A high level of automation permits a sharp reduction in the degree of human participation in production processes. Measures for freeing up manpower through automating technological processes, incorporating robot complexes and creating flexible automated types of production also require a simultaneous re-allocation of expenditures for conducting them between the spheres of production and operation.

The expenditures E_m for the manufacture of a process system, its operation E_o and the wages of machine-tool operators producing the parts E_w are determined

by the total expenditures E allocated for this purpose, that is, $E_m + E_o + E_w = E$. The total expenditures can be broken down into components in various proportions: 1. Total expenditures used completely for the manufacture of the process system; in this case, human participation in process-system operation is eliminated, and the technology of parts manufacture is fully automated. 2. Total expenditures spent completely on wages for employees directly producing the products; in this case, equipment is not used in the technological process, and the labor is manual. 3. Total expenditures spent on the manufacture and maintenance of the system; in this case, automatic equipment is used in the technological process. 4. Total expenditures are allocated in general between the spheres of process-system production and operation in certain proportions, wherein expenditures in the sphere of operation are in turn broken down into two components: expenditures for machine-tool operator wages and for the maintenance and repair of the process system.

A retrospective analysis of total expenditures makes it possible to uncover the economic development trends of process systems in the past, present and future.

With the frequent alteration of product output, the necessary quality of the manufactured parts can be obtained either through raising the qualifications of the machine-tool operators--which leads to an increase in wage expenditures--or improving the process systems, a consequence of which is growth in expenditures for their manufacture.

The resolution of the social task--freeing manpower from the production sphere--presupposes the necessity of incorporating more complex process systems, which leads to further growth in expenditures for their creation. At the same time, the use of improved process systems reduces the time for parts machining. Thus, the employment of machine tools with numerical control (NC) raises machining productivity by 5 times or more. A considerable growth in the cost of machine tools (10 times or more) leads to an increase in the cost of machine-tool-minutes, which, however, occurs 4-5 times slower than growth in equipment cost. Thus, as a result of the use of more complex process systems that provide an economy of human labor and reduce the time for machining articles, the cost of production declines.

A considerable portion of the cost of modern machine tools with NC is for electronic devices, the cost of which is falling rapidly with improvements in the technology of their manufacture. The transition to direct control using computers is bringing expenditures for preparing control programs to a minimum.

Over the last two decades, the fundamental area of improvement in machine tools has been changes in their control: manual control--numerical program control--NC using a digital indicator device--CNC-type NC--NC contour system using the Elektronika 60M microcomputer--DNC-type NC.

By way of example, we cite the cost dynamics of several models of general-purpose milling machines in order of their development over the last two decades (3):

Model	675P	6B75V	6720	6B75VF1	OF-120F2	OF-121F3	OF-100F2
Cost, thou. rubles	2.9	8.39	10.45	14.50	30.0	42.27	53.0

The development of new models of machine tools leads to an increase in their cost, but through improvements in the control system of the machine tools and the freeing up of some of the workers, a re-allocation of the correlation of expenditures occurs: E_m , E_o and E_w .

We will analyze changes in this correlation with the aid of a triangular coordinate system (figure) in which each edge of an equilateral triangle is an axis with the values E_m , E_o and E_w arranged along it expressed in percentages. Correspondingly, the sum of the coordinates of any point located inside the triangle or on one of its edges is equal to 100 percent.

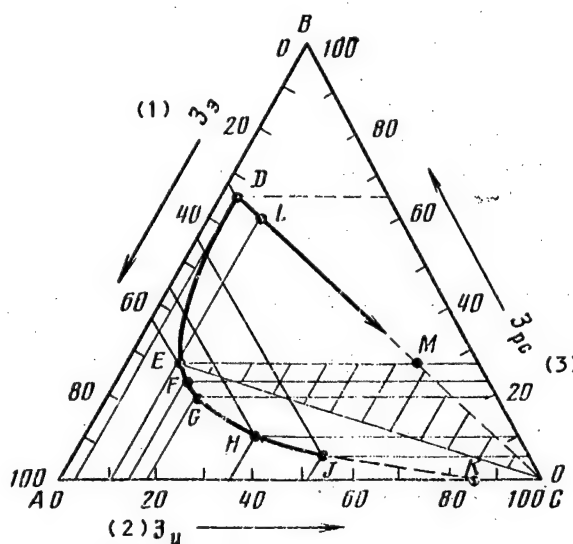


Fig. Analysis of the development of milling machines with NC (expenditures, percent)

Key: 1-- E_o ; 2-- E_m ; 3-- E_w .

We will consider several points on the triangle.

1. A ($E_m=0$, $E_w=0$, $E_o=100$). Obviously, there cannot be equipment for which manufacturing expenditures do not exist (total 0 percent. Furthermore, taking into account that E_w is also equal to zero, it is correct to assume that such a technological process does not exist.

2. B ($E_m=0$, $E_w=100$, $E_o=0$). Expenditures for equipment manufacture and operation are equal to zero. Although such equipment cannot exist, a technological process can, wherein the labor is manual.

3. C ($E_m=100$, $E_w=0$, $E_o=0$). The absence of wage expenditures for a machine-

tool operator and for machine-tool operation signifies that the equipment is automatic and self-restoring. This case should be considered the ideal which it is essential to strive toward.

4. D ($E_m \neq 0$, $E_w \neq 0$, $E_o \neq 0$). This point corresponds to the allocation of the structural components of total expenditures for the manufacture and operation of the model-675P machine tool and the wages of the machine-tool operator in its utilization (expenditures for one year of machine-tool operation).

5. E, F, G, H, J ($E_m \neq 0$, $E_w \neq 0$, $E_o \neq 0$). These points reflect the correlation of structural components in the manufacture and operation of subsequent models of general-purpose milling machines. This correlation does not remain constant. The overall trend is an increase in expenditures for the manufacture of machine tools and a decline in machine-tool operator wage expenditures.

6. K ($E_m \neq 0$, $E_w \neq 0$, $E_m + E_o = 3$). Such an allocation of total expenditures into structural components was not carried out. Both a graphical (see figure) and a substantive analysis, however, demonstrate the similar trend of the development of milling-machine designs that facilitate a further freeing up of highly qualified machine-tool operators and a reduction in machine-tool operating expenditures.

We will connect point D with point C. Since the vertex of the triangle C reflects the ideal case, a ray running from point D to this vertex will show the best direction (after the creation of the model-675P machine tool) for the re-allocation of expenditures from the point of view of the most rapid convergence to the ideal variant. Each point on this ray also determines the economically expedient direction of development of new models of machine tools, and at the same time describes the reduction in the structural components E_o and E_w and the increase of E_m .

The direction of development of subsequent models (after the creation of the model-675P machine tool) is reflected in the graph (see figure) by the curve DEFGHJ. It cannot be considered best from the point of view of economic expediency. The creation of the model-6B75V was associated with a tripling of expenditures for its manufacture. The incorporation of this model into production made possible a significant (40 percent) reduction in expenses for machine-tool operator wages, but at the same time the share of labor expended for machine-tool maintenance and operation increased by more than 30 percent. Point L on the ray DC indicates the best allocation of expenditures for the components E_o and E_w . This signifies that if the total expenditures and the expenditures for the manufacture of this model of machine tool are assigned, then the allocation of the remaining portion of the expenditures between the values E_o and E_w should be carried out in the proportion reflected in the graph by point L. This proportion can also be found analytically. For this it is necessary to note the equations of the straight lines DC and EL and solve them. The values found will also give the intersection point on the graph.

The structural components of the expenditures for the manufacture and operation of the model-675V machine tool are reflected in the drawing by point E. Expenditures for machine-tool operator wages totaled a fully defined value

in the structure of the total expenditures--28 percent. Apparently, it would be unjustified to develop designs that would increase manpower wage expenditures after the incorporation of this model into production. It is essential to proceed along the path of improving the models of the machine tools. In order to determine the rational correlation of process-system production and operation expenditures, we draw a ray from point E to point C reflecting the ideal case--fully unattended production. Then a sector is formed between lines DC and EC which defines the area of expedient allocation of these expenditures and shows the overall trend--movement toward point C.

Thus, with the availability of two successively developed models of machine tools, the following procedure needs to be carried out in implementing the expedient allocation of expenditures between the spheres of production and operation based on the requirements for freeing up manpower.

1. Establish the structural components of the total expenditures for both models.
2. Write down the equations of the two rays leading to the single point C, which reflects the ideal case (fully unattended technology), the coordinates of which rays are the structural components of expenditures for the production and operation of each model.
3. Draw a straight line parallel to the E axis and passing through the point reflecting the structural components of^m expenditures for production and operation of the latest model.

Also located between the two rays and the straight line is the area of the expedient allocation of total expenditures.

In developing the first model, the allocation of expenditures is executed in the following sequence: a) the portion of total expenditures spent on machine-tool operator wages is subtracted out; b) the remaining portion of total expenditures is allocated between the spheres of production and operation.

Why wasn't the best route chosen? An analysis of the following reasons gives the answer to this question.

1. The lack of a technique for determining the economically expedient allocation of expenditures between the spheres of production and operation for the models of machine tools under development did not permit a retrospective analysis and the determination of the trend of future development.
2. The allocation of total expenditures to structural components is possible only when the total expenses for production and operation, as well as the expenses for machine-tool operator wages, are assigned values, while the expenditures for the manufacture of machine tools are determined proceeding from quality and reliability requirements. In practice, unfortunately, these conditions are not met.
3. The total expenditures for equipment production and operation are determined by the capabilities of society, which cannot be taken to be

unlimited. At the same time, the minimization of total expenditures does not always ensure the resolution of the technical, economic and social tasks posed.

4. The achievements of scientific and technical progress and the capabilities of technology and production organization are not always fully utilized, and are sometimes inadequate for the development of the necessary machine-tool designs.

5. The multipurpose nature of the requirements made on the machine-tool designs under development and a lack of methods that ensure the comprehensive resolution of the tasks posed create uncertainty in the selection of the best of the possible versions.

The complex process of finding and developing new designs for metal-cutting machine tools was not implemented in a direction that ensured the most rapid convergence with the ideal case (point C in the figure), but in the end was directed toward it (point J). It is therefore possible to assume that expenditures for subsequent models of machine tools will be associated basically with their manufacture, maintenance and repair.

In this and successive cases, the expedient allocation of the changing total expenditures is determined not by the requirement to free up manpower, but by the requirements made for the quality of the parts that will be manufactured on these machine tools.

DETERMINING OPTIMAL PROCESS-SYSTEM RELIABILITY. The increase in the cost of the real assets of fixed capital, the continuous complication of process systems and mechanization and automation of production processes is leading to the necessity of re-allocating labor, material and financial resources between the spheres of production and operation taking into account the reliability of process systems.

The inadequate reliability of process systems with poor maintenance and repair quality is leading to such negative consequences as losses due to process-system idle time and a decline in the quality of operations carried out.

New-model metal-cutting machine tools possess high precision and higher reliability (Table 1).

Table 1

Machine-tool features	-----Model of machine tool-----						
	675P (first)	6B75V (second)	6720 (third)	6B75VF1 (fourth)	OF-12012 (fifth)	OF-12113 (sixth)	OF-100F2 (seventh)
Precision service life, thou. hours	12.5	14.5	15.0	17.0	18.0	18.0	22.0
Positioning precision, mm	0.025	0.017	0.017	0.013	0.013	0.013	0.010

Radial runout
of spindle

inner cone, mm	0.015	0.010	0.010	0.010	---	0.008	0.004
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The 675P machine tool has the worst indicators of precision and reliability, displacement on which is carried out with the aid of a screw slip pair. The use of ball-bearing and screw rocking pairs substantially improves machine-tool reliability indicators. The use of series-OF machine tools with real-time control systems that have correction blocks leads to additional growth in the reliability of the process system. The OF-121F3 machine tools have a 2R32 numerical-control device using the Elektronika 60M microcomputer, which device creates broad preconditions for raising the productivity of milling and the quality of the parts manufactured by process methods, including through tooling with systems of adaptive control and improving the preparation and correction of control programs.

We will use the data of Table 1 to study further the changes in machine-tool reliability. From the indicator describing the precision service life of the new model (another indicator of machine-tool reliability or precision can be utilized), the value of the precision service life of the first model is calculated, and the result is divided into the cost of the new and first models of the machine tool. Having carried out this operation for all of the models that have been developed, we obtain quantitative values for the increase in reliability for successive models of machine tools:

second	third	fourth	fifth	sixth	seventh
0.4	0.33	0.33	0.20	0.14	0.2

Analysis of the data shows that the increase in reliability is unstable and declined right up to the appearance of the new model. This is explained by the fact that machine-tool reliability was not among the principal technical and economic evaluations of the expediency of expenditures for the creation of new machine-tool designs, but was considered to be an accounting and reporting evaluation. Thus, expenditures for the manufacture of the OF-121F3 model increased by 14 times, while the increase in reliability per ruble of expenditure totaled 0.14 hours per ruble.

A substantial increase in reliability (by 0.4 hours per ruble) occurred as a result of the development and manufacture of the second model (6B75V) of general-purpose milling machine with NC. Table 2 presents some data that permits a comparison of this machine tool with preceding models.

Table 2

-----Model of machine tool-----

675P

6B75V

Cost of machine tool, thou. rubles	2.90	8.39
Precision service life, thou. hours	12.5	14.5
Productivity ratio	1	1.4
Operator wage ratio	1	0.35
Tool-minute cost, rubles/minute	1.2	1.6

The growth in cost of the 6B75V-model machine tool had as a consequence an increase in precision service life of 2,000 hours, an increase in labor productivity of 1.4 times and a reduction in machine-tool operator wages of 3 times. As a result of the increase in cost of the machine tool, however, the cost of one minute of its operation increased. We showed earlier that a sharp reduction in manpower expenditures for this model of machine tool led to an increase in operating expenses.

The OF-100F2 general-purpose milling machine with numerical control using microcomputers has the following distinguishing features compared to the 657P machine tool: its cost has increased by more than 18 times and labor productivity by 5 times, wages for manpower have declined considerably (by more than 10 times) and the precision service life has increased by 1.8 times. Comparing these data with the ratio of expenditures in the spheres of production and operation (point J in the figure), it is possible to draw the conclusion that this model is the best. The direction for further improving machine-tool design was shown earlier and is associated with reducing the share of expenditures for manpower and machine-tool operation. This change in expenditures can occur both with an increase in total expenditures or with a preservation of its value or a decline.

Considering total expenditures for the production and operation of a process system and expenditures for machine-tool operator wages as previously assigned values, the task of optimizing the reliability of a process system under development can be formulated: it is essential to allocate the assigned total expenditures for the components E_m and E_o in such a way that the reliability of the process system is at a maximum.

The reliability of a process system depends both on expenditures for manufacture and on expenditures for the operation of the system. Considering the idle time of the process system due to the lack of the essential manufacturing quality and operating conditions as independent events, we note that reliability is determined by the product $R_m \times R_o$. Taking into account that these components of reliability are functions of cost, we obtain the reliability of the process system overall: $R(E) = R(E_m) \times R(E_o)$.

The possible correlations of expenditures are determined by the fixed values of the total expenditures (3) E_1, E_2, \dots, E_n , wherein $E_{m1} + E_{o1} = E_1, E_{m2} + E_{o2} = E_2$ etc. Whereas the total expenditures are fully expended for the manufacture of

the process system, the operating expenditures will be equal to zero ($E_o = E - E_o = 0$) and the reliability component $R(E_o)$ will be equal to zero. Then the reliability of the process system overall will be equal to zero (since $R(E) = R(E_o) \times 0 = 0$). If considerable expenditures are directed toward the manufacture of metal-cutting equipment, then the component $R(E_o)$ will be very small, and moreover the smaller the expenditures for the manufacture of equipment, the less will be the reliability of the process system.

Consequently, the dependence of process-system reliability on manufacturing expenditures is of an extreme nature. An increase in total expenditures does not eliminate the presence of an extreme value, that is, a point that determines the correlation of expenditures in the spheres of production and operation that ensures the maximum achievable reliability of the process system, but changes the correlation of these expenditures. Furthermore, in general it is possible for more than one extreme point to exist that determines an allocation of expenditures that ensures the local maximum values of reliability for the process system, that is, the total expenditures can be allocated between the spheres of production and operation in several variations. It is then necessary to select from among the local maximum values a global one that ensures the greatest reliability for the process system. The simplest case is the presence of two local maximum values. For a certain value of total expenditures, these local maximum values will be identical, that is, from the point of view of achieving the maximum reliability, it does not matter how the expenditures are allocated between production and operation. A further increase in total expenditures violates the equality of reliability, and one of the two local maximum values will ensure greater process-system reliability. An uneven re-allocation of the expenditures E_m and E_o should be carried out when equality of the reliability to the growth in total expenditures for production and operation for a process system is achieved.

The proposed method for evaluating process systems makes it possible to allocate the expenditures for the manufacture of a process system and its operation in the best manner, and to determine the trend of their expedient re-allocation taking into account the reliability requirements of process systems and on that basis to elaborate the necessity and direction of technical retooling. Increasing total expenditures does not always ensure their continuous re-allocation between the spheres of production and operation, and with the achievement of a certain value for total expenditures this re-allocation can be uneven. These "jumps," moreover, do not necessarily occur in favor of increasing expenditures for the manufacture of process systems and reducing expenditures for their operation.

DETERMINING EXPENDITURES FOR THE MANUFACTURE OF PROCESS SYSTEMS DEPENDING ON RELIABILITY AND THE REQUIRED SAVING ACHIEVED OVER THE LIFE CYCLE OF THE SYSTEM. Under the conditions of scientific and technical revolution, the equipment and technology of production are changing at an increasing rate, and therefore methods are essential that permit the development of process systems with the required functioning period and that provide for the established saving.

This signifies that the requirements of the customer for the manufacture of a process system should not be limited by the necessity of ensuring the quality of the part being produced and the productivity of the machine tool; they should also envisage the establishment of a time period for the use of the process system and the saving obtained over the life cycle of the process system. The absence of these requirements deprives the production workers of knowledge of the time periods for effective utilization of the process system and the expedient implementation of technical retooling, while it deprives the planners of the opportunity of creating designs that would combine the time periods of obsolescence and physical wear and the most efficient use of the system. Consequently, process-system planning should be aimed at the manufacture of a defined product range of parts over the course of a required time period.

The saving from machining a required range of parts over the life cycle of the process system should be at a maximum.

Since any process system is complex and expensive, it is essential that it be used over a prolonged period. Therefore the requirements advanced by the customer should be based on a forecast of the technical and economic features of the articles that will be produced by it. The reliability of the forecast depends on the completeness of statistical information, the extent of the discovery of general development features, the articles forecast and the depth of analysis of the principal trends of the past, present and future. New difficulties arise before the customer that are caused by the undefined and unreliable nature of existing data, as well as the complexity of the interaction of forecasts with actual reality. Quite effective forecasting methods have currently been developed, using which the customer can advance well-founded requirements for the creation of new process systems.

The operation of a process system is carried out under specific conditions that ensure a certain saving over the assigned period of its utilization, the value of which does not always correspond to the planned one. The replacement of a process system with a new and improved one is possible in general either before or after the planned time period. The exact coincidence of the planned and actual time of operation of a process system occurs only in rare cases. Among the reasons for the early replacement of a process system are the creation of new types of articles not envisaged in forecasting that have to be manufactured by the process system, and the intensive development of scientific and technical progress, leading to the development of new and more efficient technologies and process systems. The use of a process system for longer than the planned time period is connected with an insufficient rate of renewal for the products being produced, a lag in the development of design and process solutions and the economic expediency of replacing the process system.

Consequently, in the course of operation it is essential to analyze the technical and economic efficiency of the process system and to compare it with the design efficiency, discover its correspondence to the achievements of scientific and technical progress and specify the operating life of the system. This comparison can be done by evaluating the increase in cumulative

economic savings in the operation of the process system, which turns out to be under the influence of two principal factors: 1) changes in economic saving in the process of operating the process system and 2) changes in expenditures for the manufacture and operation of the process system.

The first part of the increase in economic saving has a tendency toward decline, since with time more frequent and longer periods of system idle time arise in repair and maintenance, reducing its productivity. The second part of cumulative economic saving is conditional upon two components: expenditures for the manufacture of the process system that are fixed values, and expenditures for process-system operation which change over time. In planning a process system, expenditures for its manufacture should be considered a variable quantity. Increasing them leads on the one hand to a decline in cumulative economic saving, while on the other hand--through raising the quality of the process system and correspondingly reducing operating expenditures--to an increase in the cumulative economic saving.

Changes in operating expenditures have a tendency toward increase, since the aging of individual elements of the process system leads to the necessity of spending ever more funds for the renewal of its lost features.

Expenditures on the manufacture and operation of a process system, its reliability and productivity, cumulative economic saving and system service life are interconnected. This interconnection also determines the life cycle of the process system. For the expedient utilization period of a process system, the range of time between the maximum and zero values of cumulative economic saving which can be achieved over the life cycle of the system are usually adopted (2). This approach creates uncertainty in establishing the utilization period of the process system. Furthermore, taking into account that the utilization of the process system up to the instant that the cumulative economic saving becomes equal to zero is not expedient, the utilization period should be determined proceeding from the concepts described above. The planned operating life of a process system is determined by the instant the maximum value for cumulative economic saving is reached. At that instant, the increase in cumulative economic saving is equal to zero.

In establishing the general features of changes in the values described and the interconnections between them, it is possible to obtain the optimal values of the process-system reliability indicators, as well as those expenditures essential for its manufacture and operation.

This approach allows process-system planning using requirements for savings and forecast information on products subject to manufacture on the planned system, as well as the determination of the necessary expenditures for the manufacture and operation of the process system with a regard for its reliability.

PLANNING PROCESS SYSTEMS TAKING INTO ACCOUNT THE MAXIMUM UTILIZATION OF THEIR CAPABILITIES. Methods that make it possible to ensure the maximum utilization of process-system capabilities are essential in developing and manufacturing process systems according to customer orders. A surplus of capabilities in a process system leads to losses, a reduction of economic efficiency, an

increase in costs and, in the end, to increased production cost. In the process of the immediate manufacture of parts, the planned capabilities of a process system are always somewhat greater than those utilized. The discrepancy between the planned and the required capabilities of the process system for the fulfillment of its purpose are losses, or a surplus of capabilities.

The creation and utilization of process systems with unlimited capabilities would ensure the fulfillment of any process tasks with the requisite productivity. For example, machining productivity would be at a maximum in the use of a process system with continuous operation and absolute reliability. This case is ideal from the point of view of achieving the highest machining productivity, and therefore the productivity of such a system can be called ideal. Actual productivity will be lower. The closer actual productivity is to the ideal, the more completely the capabilities of the process system are utilized; the more the actual and ideal productivity differ, the greater the surplus of capabilities of the process system.

An ideally correct structure for technological processes is one in which process-system capabilities are fully utilized according to all parameters.

In mass production, the capabilities of a process system should correspond exactly to the requirements made on it according to every parameter, that is, there is no need for a surplus of capabilities. In individual production, when general-purpose equipment is used, the capabilities of the process system should be greater than the demands made on it. The surplus of process-system capabilities should therefore have an optimal value. On one hand, this creates process-system flexibility, while on the other, it makes it more expensive. Process-system flexibility, therefore, can be quantitatively evaluated for every parameter of the system as the ratio G of the difference of system capabilities V and the requirements made of it T_r to the achievable value of surplus capabilities m , that is

$$G = (V - T_r) / m.$$

It follows from this that depending on the type of production, the flexibility of process systems should vary and have its own achievable value for surplus capabilities, an increase in which leads to losses, and a decrease in which leads to violation of the requirements made for parts manufacture.

The flexibility of the process system essential for the quality manufacture of the whole range of parts being machined should ensure minimal losses; the quantitative value of the flexibility coefficient G should not exceed one. A coefficient greater than one signifies that the process system has surplus capabilities for the parameter under consideration that are not utilized in the machining of the parts for the manufacture of which the technological process was created. A value for the flexibility coefficient equal to zero signifies that the capabilities of the process system are fully utilized; $G = 1$ signifies that the capabilities correspond precisely to the established standard. The value of the flexibility coefficient depends on the established

standard for capabilities needed by the requirements and capabilities of the process system for the manufacture of parts.

The initial data for the planning of a process system are the requirements presented for the machining of parts and the standard capabilities; the result is the capabilities of the process system. Depending on the requirements made for parts machining, a process-system flexibility coefficient can be calculated, with the aid of which it is possible, in particular, to compose and classify process systems according to degree of flexibility.

The requirements made for parts machining vary; therefore, an evaluation of process-system flexibility according to all the parameters of the product range of the parts being machined is a question of probability.

Losses arise with the incomplete utilization of process-system work space, dimensions, capacity, metals consumption and the like. Considering the aggregate of process-system flexibility coefficients for each parameter as a random value, it is possible to calculate the probability of process-system losses in machining a range of parts over the period under consideration under established machining modes and conditions. This probability is taken as a quantitative evaluation of process-system flexibility for the aggregate of parameters.

Increasing the capabilities of a process system leads to an increase in the probability of losses and to growth in expenditures for the creation and operation of the system. Thus, increasing the degree of flexibility of the process system, along with a positive economic effect, leads to an increase in expenses for the creation and operation of the process system. Therefore, planning process systems under conditions of an intensification of production with limited expenditures is expediently implemented with the aid of the criterion of minimum theoretical average losses (3), defined as the product of the probability of losses and expenditures for system creation and operation. In other words, in comparing versions of process systems under development, it is necessary to select the one for which this product is the least. If the system represents a chain of process equipment, then the total of the criteria calculated for each unit of equipment is considered to be the criterion of theoretical average losses.

We will consider an example. It is necessary to plan a range of general-purpose metal-cutting machine tools. For simplicity in stating the requirements made on the machine tools being planned, one parameter is considered--the size of the parts being machined--and for the standard of capabilities--the difference among the maximum machining sizes on the adjacent machine tools from the range of general-purpose ones, which is defined as the denominator of the geometric progression F , called the series denominator.

The probability of losses will then be a function of the series denominator and the utilization factor of the capabilities of the process system, defined as the ratio of the sizes being machined to the maximum machining size. [Translator's note: pages 82-106 (end of article) of original text missing.]

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REORGANIZATION PLAN PROPOSED FOR GENERAL-PURPOSE MACHINE-BUILDING

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[Article by F. V. Kokushkin and Ye. V. Rudneva: "Organizational-Economic Mechanism for Directing General-Purpose Machine-Building Output Production Specialization Processes"]

[Text] The article describes the current level of development of general-purpose machinebuilding output production. Organizational measures aimed at delineating this production as independent planning and management targets are analyzed. Possible variants for developing the system for directing this production are studied. The appropriateness of a programmed approach to directing specialization processes for this production is substantiated. The organizational forms and economic mechanism of directing the specialization process are described.

Intermediate machine-building output, including assemblies, parts, blanks and other items produced and consumed at enterprises of all the construction ministries, has come to be called general-purpose machine-building output (hereafter called OMP). This output and OMP services currently comprise about 20 percent of machine-building gross output and employ more than 25 percent of all branch workers (1, p 109).

In current planning practice, OMP output includes 15 types of widely used intermediate machine-building output which can be divided, based on intended purpose, technological features and production organization, into OMP products (hydraulic and pneumatic drives, filtering devices, reduction gears, and so forth), blanks (castings, forgings, stampings, welded metal components, and so forth), and molded materials.¹

Although OMP production specialization and concentration has long been a focus of attention, the problems are far from having been solved. The country currently operates a great many small shops and sectors whose operating technical-economic indicators are considerably inferior to those at large production facilities. Thus, enterprises producing upwards of 10,000 tons of castings per year comprise 20 percent of all enterprises in that specialty and produce about 80 percent of the castings. The proportion of small enterprises (producing 500

to 1,000 castings per year) is also 20 percent, but they produce only 1.5 percent of all output. The net cost per ton of castings is approximately 50 percent less at enterprises of the first group, and output per worker is three times higher, than at enterprises of the second group (4, p 36).

The situation is similar in the production of OMP items. Rough calculations show that annual losses due to the higher net cost of manufacturing fasteners, hydraulic drives and automatic equipment, and welding rods at small, unspecialized shops and sectors are up to 150 million rubles, while the capital investment necessary to create capacities for the specialized production of these items would be approximately 100 to 120 million rubles (3, p 33).

Due to the low technical-economic level and the slow growth in labor productivity, annual OMP output production increment rates, particularly for blanks, lag considerably behind machine-building output growth. Thus, the annual rates of increment in machine-building and metalworking output production averaged 11.95 percent in the Ukrainian SSR in 1966-1975, while the rates were 3.2 percent for cast blanks, 1.1 percent for forgings and 3.9 percent for stampings. As a result, the annual deficit in blanks in the various machine-building branches was 5-6 percent of total demand (3, p 34).

The inadequate level of OMP output production specialization and concentration and the inefficient production capacities structure reduce the return on capital and make it harder to introduce new technologies and progressive equipment whose use has a significant impact when used in large-scale production.² The inefficient blanks structure and the low proportion of low-waste and waste-free technology at machine-building enterprises lead to significant losses of ferrous metals in machine-building.³ The list of negative effects of the low level of OMP output production specialization on machine-building development as a whole could continue.

In our view, the planning and management features of the types of production being examined here should be singled out among those factors delaying specialization of this production.

As was noted above, enterprises in all the machine-building ministries currently produce OMP output, and the proportion of this production at specialized enterprises is a small fraction of total production volume. Thus, as of the start of the 11th Five-Year Plan, 40-45 percent of the demand for hydraulic drives and automatic hydraulic units was met through centralized production facilities, 15-23 percent of the demand for lubricating and filtering equipment, 11-13 percent of the demand for castings, 11 percent of the demand for swaging and 11 percent of the demand for washed molding sand (4, p 36). A significant portion of the OMP output is produced in shops at full-service machine-building enterprises only to meet in-house needs.

The departmental scattering of OMP output production and the inadequate reliability of economic ties lead to substantial expansion of intrabranh cooperative deliveries, to the detriment of what are often more-efficient (in national economic terms) interbranch deliveries. Facilities under construction for centralized casting and forging are modified to service only enterprises of their

own branch, regardless of the territorial location of the enterprises.⁴ Thus, intrabranh blank-production cooperation is generally accompanied by increased long-distance and counter shipments, which in fact grew by 37.5 percent during 1971-1975. Long-distance shipments of castings, forgings and stampings increased by 40 percent (3, p 35). In this regard, intrabranh cooperation has developed and is developing not only at the expense of new construction, but also by disrupting delivery operations which have evolved over a long period, which has particularly unfavorable consequences, since it necessitates the creation of new production facilities which are often primitive.

A number of steps have been taken to eliminate these negative consequences of the "fragmentation" of OMP output production by improving its planning and management. In particular, since 1966, the annual and five-year plans have had a separate section on "Developing Specialized OMP Output Production Capacities." An attempt is underway in the USSR Minstankoprom [Ministry of Machine Tool and Tool Building Production] to create a corresponding machine-building subbranch using specially-allocated target capital investments. The Minstankoprom has created four VPO [all-union production associations] to direct facilities being created to produce the different types of OMP output: "Soyuzmashnormal," "Soyuzgidravlika," "Soyuzlitprom" and "Soyuzformomaterialy." The USSR Gosplan and Gossnab have created subdivisions responsible for planning the development of OMP output production and for supply and marketing, respectively. The machine-building ministries have been entrusted with the responsibility for developing centralized production and for the technical level and quality of OMP output in the products mix assigned them, and the Minstankoprom has been entrusted with coordinating implementation of a unified technical policy in the area of centralized OMP production. An OMP output production coordination administration has been formed to resolve these tasks within its framework. Work is continuing on developing the planning technology and indicators for developing interbranch production facilities. All ministries, departments and councils of ministers of the union republics are to have national economic plan line-item assignments on OMP output production volumes in physical terms, increment in specialized production capacities, and capital investments. All plan indicators are to be used when planning development of the corresponding Minstankoprom subbranch. All this enables us to speak of an aggregate of OMP output production facilities being delineated, in stages, as an independent planning target and, to an extent, an independent management target.

However, OMP output production development results have shown that the indicated measures alone have not succeeded in ensuring fundamental resolution of these specialization and concentration questions. This is borne out by data from a special USSR Central Statistical Administration survey which showed that 71 percent of the machine-building enterprises are currently producing their own iron castings, 27 percent are producing their own steel castings, 84 percent their own forgings, 76 percent their own stampings, and 65 percent are producing their own fasteners (4, p 36). In spite of the trend towards concentrating casting production, the proportion of foundries with an annual output of less than 1,000 tons has remained practically unchanged for the past 20 years (4, p 101).

The steps taken to improve OMP output production planning and management have not ensured the elimination of all those organizational and administrative factors which have hampered the specialization of this production. In fact, direction of the administration of the branch producing OMP output and planning its activity have remained scattered among several agencies which lack full responsibility for meeting the demand for OMP output and for conducting a unified technical and economic policy in this branch.

The USSR Gosplan has ensured planning only of the operation of the machine-building group of ministries in terms of a specific products mix and has monitored fulfillment of those plans to a certain extent. In this regard, the planning and monitoring have been done for each ministry individually, including individual ministry target capital investment plans, with no provision for maneuvering in the course of plan implementation. Moreover, the ministries strive to have resources allocated for developing capacities to produce blanks and assembly components only in amounts sufficient to meet their own requirements. Attempts by the USSR Gosplan to obligate the ministries to develop their own capacities to the levels necessary to meet the requirements of other enterprises in the same region have generally been unsuccessful.

The USSR Gossnab is working to determine and meet the requirements of the ministries and union republics for OMP output only insofar as they are linked to interbranch and interrepublic deliveries. It does not determine the total demand for this output and does not participate in planning intraministerial coordination ties, so opportunities for eliminating inefficient shipments and organizing effective intraministerial and intraregional ties are therefore limited.

The Minstankoprom is not in a position to coordinate the development of interbranch production facilities by other ministries effectively due to a lack of effective levers with which to influence them. Moreover, this ministry itself uses the output of the specialized production facilities under it primarily to meet intrabranh requirements.

The inadequacy of these measures to improve OMP output production planning and management demands that more-effective ways of guiding interbranch production facility specialization and development processes be sought. Let us examine a number of the proposals in this area.

It has repeatedly been proposed in the past that a union ministry of OMP production be created (see, for example, works 2 and 7). Its production base would be enterprises specialized to produce this output, enterprises currently under various machine-building ministries. Under the existing management system, such an approach would ensure positive advances in solving the problems of creating specialized capacities of an optimum size, of further developing standardization and unitization, of conducting a unified technical policy, and a number of others.

At the same time, when this approach is evaluated from the viewpoint of whether it fundamentally solves the specialization problem, consideration should be given to the fact that a large portion of the OMP output is produced in shops and sectors being operated full-time as part of machine-building enterprises. Under

these conditions, collectivizing them territorially is impossible, and so subordinating them administratively is extremely complicated. Practical experience shows that it is impossible at present for a lead ministry to provide managerial guidance to shops and sectors comprising multipurpose plants.

In terms of production volume, the new ministry would be considerably smaller than the average-sized machine-building ministry and would meet only a small fraction of the demand for OMP output. It can therefore be assumed that the main focus of its activity would be the creation and development of corresponding territorially and administratively isolated production facilities which would be subordinated to it. In light of how time consuming and expensive it is in terms of capital investment to create interbranch production facilities, one might conclude that the process of creating the production base for such a ministry would cover several five-year plans and would, we estimate, require on the order of 10 billion rubles in capital investment.

When evaluating a strategy of this type as a whole, one can say that it enables us to solve a number of existing problems, although many remain open questions, particularly the effective use and development of existing production capacities. But its main shortcoming is that it is oriented towards an extensive path of development and assumes primarily the large-scale creation of new production capacities.

Strengthening the territorial aspect of management is another possible area in which OMP output production planning and management might be improved. Let us examine this variant using blank production as an example. It assumes the transfer of centralized production facilities to the union republic councils of ministers. It also assumes that the machine-building ministries will develop existing capacities to produce blanks for in-house consumption and create new ones only if it is economically and technically effective to do so. If a production facility being created or renovated does not satisfy this condition, ministry blank requirements must be met by developing a centralized production facility. The councils of ministers would be allocated line-item capital investments to create and renovate billet production capacities over and above the resources designated for developing union-republic industry and would be made available by the USSR Gosplan by centralizing a portion of the machine-building and nonmachine-building ministry capital investments designated for developing the production of blanks. Specialized production associations would direct this production within each union republic or, if there are several such associations, republic industrial associations subordinated to the councils of ministers would be created.

The advantages of this variant are first of all that the planning and management system it anticipates ensures comprehensive, steady satisfaction of the blank requirements of all republic branches of the national economy and permits concentrating resources designated for developing billet production and distributing them in such a way that inefficient transport expenses are avoided and optimum-sized capacities are created. Moreover, it provides an opportunity for flexible, responsive maneuvering of resources and the accelerated creation and start-up of new capacities, inasmuch as the bulk of the construction organizations are run by the union republics.

However, this variant also has a number of shortcomings. First, difficulties in conducting a unified technical policy in the branch arise when implementing it. One would therefore need to create a union-level agency responsible for that policy. Second, the level of and increment in requirements for individual types of blanks in a number of union republics, such as Lithuania, Armenia, Georgia and Azerbaijan, would not require the creation of optimum-sized, centralized production facilities. Third, it is readily apparent that this variant, like the preceding one, does not ensure effective management of the use and development of capacities which are part of multipurpose enterprises.

Thus, both taking a number of steps to improve OMP output production planning and management and the proposals examined above for changing the management structure fail to provide opportunities to solve the problem of its effective specialization. What is required is a superdepartmental, centralized approach relying on a complex of transformations in the area of organizing the management of interbranch production facilities and planning their development, the allocation and distribution of resources, and economic incentives for the producers and consumers of OMP output. Such an approach can be provided by programmed planning and management methods.⁵

However, use of these methods can cover different stages of resolution of the problem. As is currently being done in implementing a number of national economic programs, this complex of programmed measures can be implemented using plan coordination methods, that is, by conveying to the ministries program assignments along with other assignments of the state economic and social development plans and by monitoring their implementation to an extent. In our view, such an approach to solving the problem of specializing OMP output production is inadequate. Programmed methods must also be used in the implementation stage, that is, a "full-cycle" program must be implemented. This is determined by the current status of the program target, which determines the features of the OMP output production specialization process and the methods of directing that process.

As was noted above, a considerable portion of this output is produced in shops at multipurpose machine-building enterprises on general-purpose equipment to meet in-house needs. Retention of such shops, whose technical-economic operating indicators are considerably inferior to analogous indicators at specialized production facilities⁶ and whose activities are often unprofitable, is due to a number of factors, in particular, to the inadequate reliability and stability of cooperation ties, as well as to the fact that existing capacities at specialized production facilities are not in a position to meet the total demand for OMP output. Given this inadequate reliability of economic ties, the ministries try to be self-sufficient, by first developing intrabranh cooperation ties on which they can have a direct impact, to the detriment of interbranch ties, which are often more effective. Thus, the process of specializing OMP output production has two interconnected aspects: accelerated development of specialized production (including centralized production facilities) and specialized shops of optimum size, and the establishment of effective cooperation ties.

Solving the specialization problem requires determining facilities to be specialized, with consideration being given to a number of factors: the technical status of the facility, the demand for the products, enterprise location,

available workforce, and others. Quite understandably, the resolution of this problem may differ with the different intrabranh and national economic positions. In particular, intrabranh demand for a certain type of OMP output may be slight, making it appear appropriate to retain the existing production structure and organization. As was noted above, the intrabranh approach to solving specialization problems often leads to inefficient production facility siting and to significant transport expenditures. Specialization problems must therefore be resolved from unified national economic positions.⁷ However, experience has shown that the implementation of decrees on problems of developing OMP output production and implementation of resolutions on specialization through machine-building ministry assignments do not guarantee their precise implementation. Thus, implementation of a national economic program of OMP output production specialization based on plan coordination methods may also fail to lead to fundamental resolution of the problem.

Another way of solving it is to completely separate, administratively, the shops of multipurpose machine-building enterprises producing OMP output and to transfer them to, for example, a new union ministry, that is, to single out the aggregate of facilities producing this output as a departmental branch. This, too, proves inefficient, as it leads to disruptions in implementation of the production program by the multipurpose machine-building enterprises.

In our view, the following would be more effective: gradual economic isolation of OMP output production facilities and then separating them administratively and economically. As a result, a multipurpose machine-building enterprise would yield two (possibly more) independent production facilities at one site.⁸ The economic impact of the OMP output would at the same time necessarily and substantially increase, due to the intensified specialization and bringing the capacities to an optimum size in the course of retooling, renovation and expansion.

In order to implement this specialization strategy, along with resolving the tasks of flexible management of production facilities gradually being isolated, a tremendous amount of registration certification needs to be done in the shops comprising multipurpose machine-building enterprises to develop optimum specialization proposals and charts of cooperation ties. This requires the creation of a system of agencies with certain powers, including in the area of resources distribution and redistribution. Thus, in order to effectively solve OMP output production specialization problems, it is appropriate to create an organizational-economic mechanism for directing program implementation which includes a system of program agencies⁹ and forms and methods for allocating and distributing resources and providing the implementers with incentives. The highest link in the hierarchy of program management agencies must be a union-level agency with status equal to that of the existing machine-building ministries. The Main Administration for OMP Output Production Specialization attached to the USSR Council of Ministries could be such an agency. As for the lower-level program agencies, their staffs, basic functions and powers would be based on subprograms¹⁰ which we feel should be delineated in accordance with untypical types of production predetermining the features of the control systems (subprograms for developing production specialization in OMP items, blanks and molding materials). Let's examine the organizational-economic mechanism for directing implementation of these three types of subprograms.

OMP items possess a very high degree of unitization and standardization. They are characterized by relatively small dimensions and light weight and by significant expenditures of embodied labor. Their most important design parameters are strictly regulated, and finished OMP products require no additional work prior to use. Their manufacture uses relatively little metal. This group of products therefore has practically no limitations in terms of transport and consumption, and production indicators for it improve as production scale increases. All this permits the creation of large-series and mass production for OMP items.

At present, finding suitable forms of billet production development and specialization management presents the greatest difficulties. As opposed to OMP items, the production of blanks generally requires less embodied labor per unit of size and weight. Given the poor unitization and standardization of machine-building parts and items, the products mix and specific features of the blanks are extremely large. Consideration should be given to the fact that all design changes and updating of end products and all plan adjustments involving volume and products mix cause substantial changes in the production of blanks. Their manufacture also uses considerable metal. As a result, this group of OMP products has a limited range of transport. It is therefore important to take the transport factor into account when setting up and siting blank production, and it is necessary to closely interlink this production with other machine-building process stages.

The most isolated of all the types of OMP production are molding sand (natural and washed) and auxiliary molding materials. Thus, quarries subordinated to the "Soyuzformomaterialy" VPO currently supply 82 percent of the molding sand used in foundries (3, p 149). Large sand quarries are very efficient, but the output itself has limited transportability. Inasmuch as foundries are the largest consumers of molding materials, and inasmuch as the quality of those materials has a considerable effect on casting quality, the geometric precision of the blanks and the number of defects, questions of improving our planning and management of the development of this type of production must be linked to steps to improve the management of blank production.

The extensive opportunities for intensifying OMP item production specialization permit the use of highly mechanized and automated enterprises with few manufacturing-production personnel (PPP) as the production base. Increased concentration of the production of similar products will be a condition for their efficient operation. Organizing the production of OMP items generally does not require the use of single-purpose equipment. The specialization of a number of small and medium-sized machine-building ministry enterprises to produce OMP items and their subsequent transfer to program agencies therefore seems to be an efficient way to attain the program's goals. As they possess a full range of equipment and a comprehensive structure, machine-building enterprises converted to produce OMP items would be capable of mastering their production quickly. Under these conditions, we could avoid "dead spots" in the use of production capacities and perceptible reductions in production volume, which would permit the rejection of significant new construction. The proposed measures could therefore be carried out relatively quickly (within the space of a single five-year plan). The main avenue for improving the production of OMP items would be intensified plant specialization for specific products.

Since the basic task of the program agencies at this stage will be to decide routine questions of setting up the production and improving its technology, it will be efficient to create relatively small production associations (PO) specialized by (sub)type of OMP item as the basic management link.

The second phase in implementing the OMP items subprogram will consist of transforming the multipurpose capacities producing this output into specialized capacities. In this period, the comprehensive production structure will be transformed into a staged-process structure through retooling, renovation and expansion. The enterprises producing OMP items will begin to include those specialized based on technological, subassembly and mechanical assembly criteria. The specialization of production facilities will result in considerable consolidation of production associations, that is, in changes in the structure of the mid-level management agencies. Large associations (combines) responsible for meeting the demand for specific (sub)types of OMP items will need to be created based on the aggregate of enterprises specialized based on technological, parts and mechanical assembly criteria. As we see, subprogram implementation management for this type of OMP output deals only with setting up production management and makes no substantial changes in the way in which resources are distributed.

A considerably different mechanism is required to direct implementation of the subprogram for specializing facilities producing blanks. Inasmuch as the overwhelming majority of such production facilities are part of multipurpose enterprises, and inasmuch as their operation is closely associated with the operation of other machine-building process stages, it is currently inefficient to directly separate existing shops and sectors producing blanks and create independent specialized enterprises. As was already stated, the reference here is to gradual economic isolation and subsequent administrative separation.

The necessity of coordinating the work of a significant number of participants [in] measures to specialize blank production and of making certain changes in the existing mechanism for distributing resources demand the creation of a system of mid-link program management agencies directly subordinated, as are the OMP items production specialization management subsystems, to a central program agency (TsPO). The limited transportability of the blanks and the necessity of developing effective interbranch ties make it appropriate to develop a system of territorially-based agencies.

It seems most natural to delineate program agencies on the basis of the country's administrative-territorial divisions. It is therefore efficient to create a union-republic management system in the initial stage of implementing the program. For the larger union republics, the RSFSR and Ukrainian SSR in particular, it would include a TsPO, a republic-level program agency, an economic region program agency (POER), and enterprises. It would be a three-link system (no POER) in the other union republics. A structure such as this would permit the use of existing management agencies and ensure that party and soviet agencies could counter bureaucratic interests.

However, as we know, the siting density and level of development of blank production do not correspond to the country's administrative-territorial divisions.

Studying the siting and development of production capacities within the framework of the program would therefore lead to refinement of the management targets and the regionalization boundaries. This would demand changes in the POER system. Subsequently, when directing implementation of the program, there would be a transition to a universal three-link structure: TsPO, POER, enterprises.

Let's examine the main tasks and functions of middle-link management agencies. These include information and analysis functions: coordinating the registration certification of existing shops and sectors producing blanks, generalizing the results and using them to shape proposals on optimal specialization and intraregional cooperation ties charts. POER functions obviously must include managing enterprises specialized for blank production within the regions subordinated to the POER. Finally, the most important POER task is to direct the economic isolation of blank production capacities. Resolution of this task requires the extensive use of economic levers and incentives.

The process of economically isolating capacities to produce blanks presupposes eliminating the narrow framework of departmental management which, as was shown above, hinder effective specialization. In other words, the process assumes restricting machine-building ministry apparatus opportunities for influencing the development and operation of shops and sectors producing blanks. Different variants of such restriction may be proposed (granting influence only over the operation of capacities being used at some base point in time, limiting influence only to the annual plan, setting influence boundaries at capacities actually available). Substantive review of the variants proposed will enable us to disclose the advantages of the latter. In that instance, the ministries would retain the right to influence production levels within the framework of capacities operating at some specified point in time. At the same time, they are denied the right to make decisions on questions involving the development and use of new or renovated capacities if they are not allocating resources for these purposes.

It should be noted that the process of managing the resources designated for program implementation, foremost capital investments, can be set up in various ways. For example, it could be done using the existing procedure for allocating targeted capital investments directly to the machine-building ministries. Another variant, and one we consider efficient from the positions of accelerating the specialization process, is to centralize capital investment resources designated for developing blank production and giving the POER's the right to allocate them as the clients for new and renovated facilities. At the same time, new equipment being incorporated in billet sectors and shops at multi-purpose plants in the course of the specialization, during retooling, renovation and expansion, should be leased to the enterprises. The POER's would be the organizations offering the equipment for lease. One encounters examples of this situation in capital construction. The interests of each of the parties demand that each be given the right to abrogate the lease agreement at any time. For the POER, this right would be an additional guarantee of ministry administrative noninterference in the operation of new capacities if such influence were counter to the measures of the program. The enterprises would be confident that the POER would ensure the creation of conditions for marketing their output and providing the necessary resources.

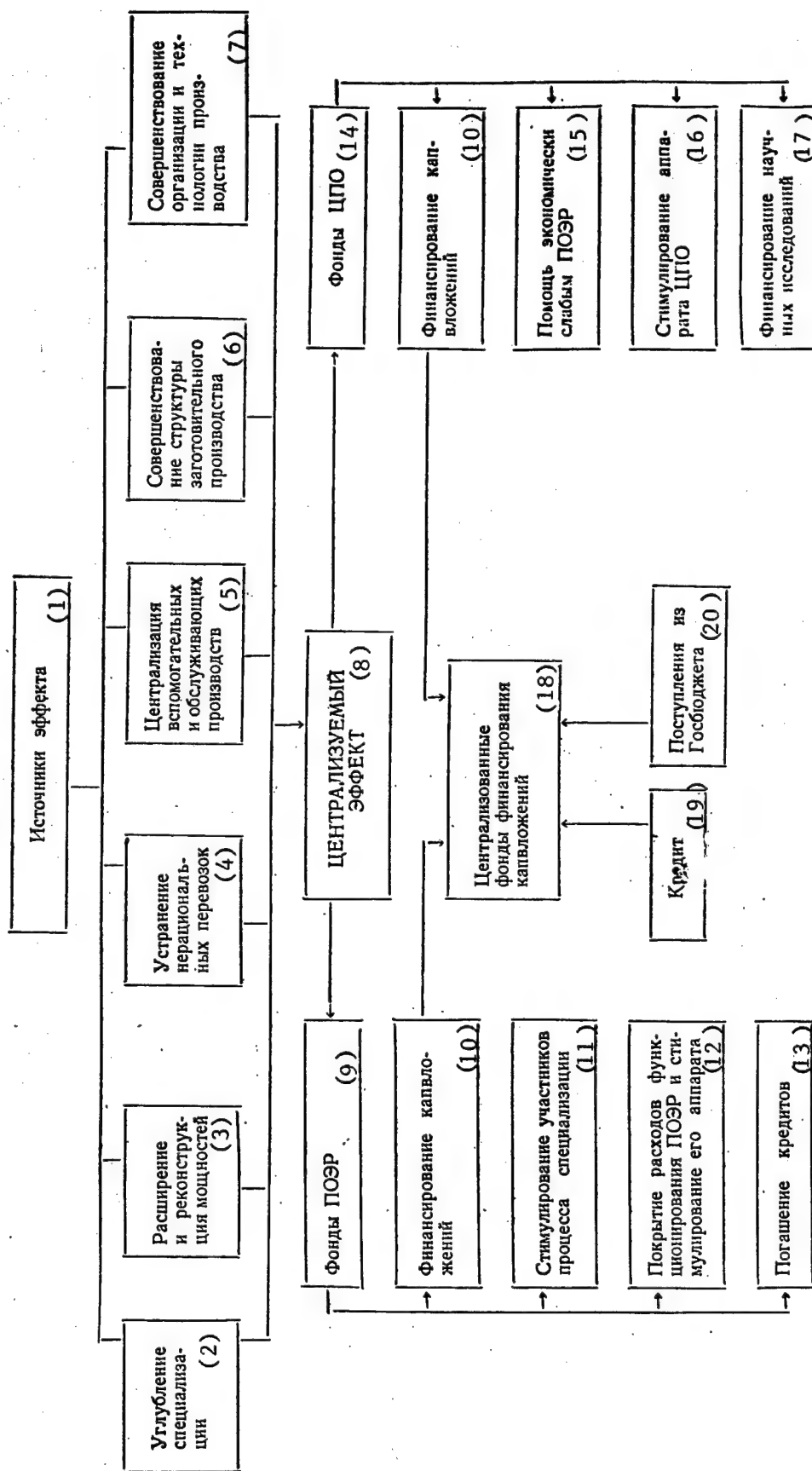
Developing specialization causes a sharp increase in the number and volume of cooperative deliveries. This aspect deserves special examination, since the reference is to production processes which, if uneven, can cause considerable difficulties in meeting end-product assignments. Mandatory performance of deliveries in terms of volume, schedules and products mix, with an overall increase in the role of contract obligations, must therefore be the basis of the proposed blank production management system.

However, a number of factors which cannot reasonably be taken fully into account in the course of drawing up a plan and concluding economic agreements influence the stability of billet shop and sector production program fulfillment. First, adjustments in plan assignments for machine-building end products may cause changes in the demand for blanks. Second, the constant improvements in the technologies for manufacturing machinery and mechanisms and the components of individual subassemblies and units and the modernization of items as a whole have the same result. The necessity of taking these factors into account points out the urgency of having some back-up capacities for producing blanks, and it also requires establishing an ability to conclude emergency delivery contracts, to write one-time orders, and so forth. In order to best meet the interests of the consumers and producers of blanks, back-up capacity maintenance expenses must be paid on a progressive scale, the payment being determined as a function of its relationship to total deliveries under the contract.¹¹ This will put enterprises with different production levels on an equal footing.

Intensified specialization, an optimized production base, and the elimination of inefficient shipments will ensure increased economic effectiveness in the production and consumption of blanks. The impact of implementing these program measured will be expressed in increased consumer profit as a result of reduced transport outlays and also in increased profit for blank producers (if the output is marketed at base prices) or consumers (if blank prices are reduced). Various methods of allocating and distributing the impact obtained are possible. When prices drop, the impact will be concentrated in the consumers. This will increase machine-building enterprise interest in becoming consumers of blanks. Moreover, in the initial stages of the specialization process, this will work to the disadvantage of the small and medium-sized enterprises whose production outlays are higher. At the same time, specialization will facilitate lowering output net cost and equalizing individual expenditures, which will be a basis for lowering blank prices. A second method, retaining prices at the base level, leads to the impact being concentrated in the producers. On the one hand, this fails to interest enterprises in cutting back their in-house production of blanks and becoming consumers, but on the other, it intensifies the differentiation of producer enterprises and creates conditions for slowing the specialization process.

In our view, it is appropriate in the initial stage of the program to retain a base price level, on the condition that all or a portion of the resulting impact is centralized in POER funds. In subsequent stages, as the necessary prerequisites are created, blank prices will drop. One method of centralizing the economic impact might be to stipulate in delivery economic agreements concluded with POER assistance that portion of blank producer and consumer additional planned profit which is to be subject to transfer to the POER.

Impact Concentration and Distribution Diagram



[Key to diagram on following page]

[Key to diagram, preceding page:]

1. Impact sources
2. Intensified specialization
3. Expansion and renovation of capacities
4. Elimination of inefficient shipments
5. Centralization of auxiliary and service types of production
6. Improvement in the structure of blank production
7. Improvement in production organization and technology
8. Centralized impact
9. POER funds
10. Capital investment financing
11. Incentives to participants in the specialization process
12. Covering POER operating expenses and incentives to the POER apparatus
13. Loan repayment
14. TsPO funds
15. Assistance to economically weak POER's
16. Incentives to the TsPO apparatus
17. Financing scientific research
18. Centralized capital investment financing
19. Credit
20. State budget receipts

It is proposed that the financial resources centralized in the POER's be used in the following areas: 1) to generate centralized capital investment funds; 2) to cover loans obtained by the POER's and pay the interest on them; 3) to meet POER financing needs and provide incentives to its apparatus; 4) to provide incentives to enterprises participating in the specialization process. A certain portion of the funds generated by deducting from the total centralized impact planned POER expenses in the four indicated areas will be transferred to the TsPO fund. The sources and uses of the centralized portion of the economic impact of the program measures are shown in the diagram on the previous page.

Inasmuch as it is assumed that POER activity will be on a cost-accounting basis, the basic principles of payments to it need to be defined. A substantive review of the functions of this agency indicates that the number of agreements concluded must be the capital-generating indicator for the financial resources designated for POER maintenance (buildings and structures, office equipment, wages). It is this indicator which best reflects the labor intensiveness of the optimization calculations, preparing proposals on developing optimization and consolidation, drawing up agreements with interested parties, and supervising their implementation. But inasmuch as the number of agreements concluded can fluctuate from year to year, it is proposed that the fund under consideration be based on a stable normative and the sliding average number of agreements over the past 3-5 years. As concerns incentives for POER workers, the funds for that must be linked in the first stage of program implementation to the increment in profit obtained by specializing and by eliminating inefficient shipments, then (as this increment begins to decrease) to the overall centralized impact.

In this article, we have described the general outline of an organizational-economic mechanism for directing implementation of a program to specialize the

production of OMP output. Space does not permit describing it in detail. This applies in particular to the description of TsPO functions. Various aspects of the activity of participants in the specialization process, and foremost the system of normatives to be used (price levels, normatives for deductions to centralized funds, generation of economic incentives funds, and others), also need concretization. To do this, we might use models simulating the activity of the various participants to "play out" various economic situations and evaluate the effect of changes in the normatives on their interaction, on production development indicators, and on the intensiveness of the specialization process.

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1. It should be noted that there has thus far been no agreement on the nomenclature for OMP output. Thus, work (2) delineated 50 different items and services whose production could effectively be centralized. Work (3) added to them tools, technological processes, heat treatment, electroplating, equipment repair, and so on. Let me stress that the products mix of OMP output has tended to increase steadily and depends directly on the level of item unitization and standardization in machine-building.
 2. Thus, the availability of equipment in foundries, and especially in small ones, is less than that in machine shops. For example, the availability of fixed assets to labor in them is 40-50 percent less, the availability of power tools is 30-60 percent less, the provision of workers with mechanisms is 50-60 percent less, and the level of labor mechanization is 70-80 percent less (5, p 95).
 3. In die forging, metal use per ton of blanks averages 1.27 tons. The proportion of blanks obtained by swaging, where the metal use factor does not exceed 0.3 - 0.5, is about 28 percent, but the proportion obtained by precision forging, where the metal use factor reaches 0.85, is less than 20 percent (5, p 95).
 4. For example, "Tsentrolit" (Rustava) output is designated mainly for enterprises of the USSR Minstankoprom. It is shipped to 35 customers, not only in the Northern Caucasus and Transcaucasus, but also in Moldavia, the Ukraine, Gorkiy Oblast and Moscow (6, p 21).
 5. Without dwelling on descriptions of the features of programmed methods, which are to be found in work (8), let us note the following. The possibility and appropriateness of a programmed approach to solving the problem of specializing OMP output production are determined by a number of factors: the impossibility of solving this problem using the available planning and management organizational forms and methods, a limited target including only a couple of subbranches of machine-building, limited time available for solving the problem, inadequacies of alternative methods of improving OMP output production planning and management.

[footnotes continue on following page]

[footnotes, continued]

6. Small shops and sectors producing less than 5,000 tons of output per year comprise upwards of 80 percent of all foundry production. They produce slightly more than 10 percent of all castings. Over 55 percent of their molding work is done by hand, and labor productivity is 50 percent lower than in shops producing 20,000 to 50,000 tons per year. Approximately the same ratios apply to forging production and welded metal components shops (5, p 101).
7. Work has been in progress in this area since 1980 within the framework of preparing the comprehensive national economic program "Creating A Highly Specialized Industry to Produce OMP Output." That work continues.
8. There are already examples of this kind of separation of production facilities in stages. Thus, the steel casting shop at the Baku Plant imeni Sardarov was considerably expanded and transformed into the independent Baku Steel Casting Plant.
9. After the program has been carried out, the system of agencies directing its implementation can be used to form permanent agencies to manage the resulting branch of industry. Their status and structure will depend on the answer to the question of machine-building management organization as a whole. For example, if the existing branch system of management agencies is retained, the central management agency for this program might be transformed into a union-level ministry for OMP production and the mid-level systems might become production associations.
10. It should be noted that, inasmuch as the management target will change in the course of implementing the program, there may also need to be transformations in the system of program agencies as well.
11. In our view, these demands must be extended both to instances in which actual demand is greater than planned and to situations in which production capacities are underloaded.

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11052

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INDUSTRY PLANNING AND ECONOMICS

RESPONSE TO CALL FOR TIGHTER CONTROL ON FOREIGN IMPORTS

Moscow EKONOMICHESKAYA GAZETA in Russian No 39, Sep 86 p 20

[Article by B. Rachkov under the heading "Strict Monitoring of Equipment Imports": "Why Doesn't the PTs-4 Work?"]

[Text] The "Strict Monitoring of Equipment Imports!" article by V. Zhukov in EKONOMICHESKAYA GAZETA No 21 received strong reader response. A number of those responses have been published in issues 27, 29, 31 and 33. In this issue, we continue the discussion of why imported equipment sometimes does not ever reach contract-stipulated efficiency.

Judging by the mail from readers, and based on my own observations, I have concluded that the unsatisfactory operation of imported equipment results primarily from shortcomings in our own use of it. Of course, there are mechanical problems for which our foreign business partners are to blame, and when that is so, we need to do everything necessary to ensure that our plants receive only high-quality equipment.

The labor collective at the Voronezh Forge and Press Equipment Plant had high hopes for a new manufacturing center (the PTs-4), an automated sector equipped with four large horizontal boring machines. Many enterprise operation indicators were to have risen as the new sector was put into operation. There was also to have been an appreciable increase in the Voronezh workers' contribution to Soviet deliveries of forge and press equipment abroad. For that reason, there were no qualms about spending nearly five million rubles to purchase this automated sector on the foreign market. Calculations showed that the expenditure would be quickly recompensed.

Contract and Partners

The very products mix made the purchase complicated. It included, in addition to the four large, high-precision NPC machine tools, an equal number of swiveling tables and handling plates capable of feeding blanks weighing many tons to the machine tool on instructions from a program. The sector also included much other sophisticated equipment. But the Voronezh workers were emboldened by the fact that solid organizations were behind them.

That meant first of all the plant's immediate superior, the Ministry of Machine Tool and Tool Building Industry, which, as is its job, drew up the specifications for the automated sector and was the actual orderer of the equipment. The "Stankoimport" All-Union Foreign Trade Association represented the client's interests in the foreign market. The organization is well known, both here and abroad. It was decided to buy the equipment needed for the sector from a well-known foreign equipment supplier.

The contract for the automated sector was concluded in November 1983. Four Soviet officials signed it: the director general of the "Stankoimport," the director of that association's "Stankosistema" company, and two officials from the Ministry of Machine Tool and Tool Building Industry.

The first shipments began arriving in Voronezh in 1984. As was stipulated in the contract, it was installed on an oversight basis, that is, with the participation of supplier representatives. The installation was completed in June 1985. Start-up and adjustment work had already begun in August, also with the participation of the foreign supplier, as agreed. The automated sector was to have begun operating in first-quarter 1986, but that did not happen.

We can begin with the fact that the Voronezh plant dragged its feet in preparing the foundation and workspace for the PTs-4 and did not deal promptly with training its people to operate some of the new automated center's subassemblies, with the fact that it did not display sufficient flexibility and persistence in sending its own specialists abroad to accept the equipment purchased.

This lack of proper organization and flexibility has characterized the whole of the contract's performance.

The General Terms for Delivery of Goods (OUP) contracted to by the partner countries provide for mandatory provision of technical documentation for the equipment being delivered in a language agreed to by the seller and buyer. In particular, the contract concerned states, in Point 2 of Paragraph 11: "The seller is obliged to include in crate No 1 of each lot two sets of documentation in Russian." However, a number of documentation sets were found to be missing when the equipment arrived in Voronezh, and some copies were supplied in other languages. This led to extensive correspondence between the foreign-trade intermediaries and delayed the start of operations.

As things progressed, some defects in the equipment which could have easily been eliminated at the foreign-seller's plant were discovered. Fortunately, the contract clearly provided a procedure and timetable for the customer to inspect each complete mechanism. Thus, Point 1 of Paragraph 9 states: "The customer has the right to send his own inspectors to the seller's manufacturing plant, during any normal business hours agreed to by the seller..., and the seller must provide the customer's inspectors the necessary equipment and premises free of charge." But neither the customer's representatives (Stankoimport) nor the client's inspectors (Ministry of Machine Tool and Tool Building Industry) nor the recipient plant inspected the equipment properly at the point of delivery. This was prologue to the technical defects' only being discovered after the equipment reached Voronezh.

One such defect, noted in a letter from the director of the Voronezh plant to the Ministry of Machine Tool and Tool Building Industry leadership on 21 March 1986, made it impossible to interchange handling plants, "thus negating the primary purpose of developing this particular automated sector."

The purchase of complex equipment assumes that final testing of its completed units must be thorough, that is, with them interacting. The contract must provide for comprehensive testing of the primary mechanisms. However, through the fault of our workers, this contract did not contain such a clause. The machine tools, swivelling tables and handling plates were not tested interacting, but separately. Each piece of equipment was declared suitable individually. When they were switched on to automatic, however, it was not a smooth-running line. One of the primary conditions for smooth operation is the interaction of the plates. The deviations in geometric accuracy discovered in them dooms each of the four machine tools to isolated, "autonomous" operation. And it would require quite a bit of effort, if it were even possible, to correct the dimensions of the plates.

The equipment moving through foreign trade channels is increasingly complex. On-site adjustments sometimes involve unexpected difficulties. Given good co-operation by the partners, however, even mistakes need not be serious obstacles.

It should not seem strange that, given the wide variety of foreign economic ties, we rely so much on the contract. All business cooperation begins with the contract, and it brooks no approximation, binding the parties to precise, coordinated actions. Preciseness and responsibility have never hampered mutually advantageous foreign economic relations.

A. A. Stepanishchev, director general of the Voronezh Forge and Press Equipment Plant, has been sending Moscow alarm signals since last August [1985], each time addressing them to the next-higher purchasing agent and superior. There have been almost no results, sometimes not even replies.

In fact, though, who should be held accountable? Of the four officials who ratified the contract for the Soviet party, only one is dealing with it today, "Stankosistema" director V. V. Rogozin. Practically admitting his inability to have a positive impact on resolving the problems on his own, Rogozin advised the Voronezh plant in a 1 July telegram to "ask the USSR Chamber of Commerce and Industry to draw up a formal claim" and send it on to the foreign supplier.

Nothing remained to the Voronezh people but to send out the first S.O.S., in the form of a telegram fired off to the Moscow Chamber: "We request that an expert immediately be sent to examine the mechanical condition of the PTs-4. We will pay for it."

Throughout all this, only the Voronezh plant appears to have really suffered. Its plans were disrupted, meaning losses to the national economy.

Given all the equipment's faults it could correct itself, the plant does not yet have the rights or powers to have a real influence on the positions of its own partners here at home, much less abroad.

When you talk with the energetic A. A. Stepanishchev and with the inquisitive young engineers working here, S. N. Bualvin, V. I. Drugov, A. T. Strkalov, B. Ye. Bratishchev and M. L. Shereshevskiy, when you see the efficient attachments, almost inventions, they have developed to "bridge the gaps" in the new sector, you are really distressed at how much energy and creative effort has been cut off from foreign economic activity which is of considerable national economic importance. Here is the human factor we talk about, removed in this case from those levers which are contributing successfully to increasing the efficiency of our economy in many sectors.

Were such people to have participated in drawing up contracts and in inspecting the finished equipment at every stage, they would probably not have omitted the comprehensive testing clause or let technical defects or crates with improper documentation be ignored. Just in general, their more active involvement in the foreign economic sphere would have eliminated much potential confusion ahead of time and would have put the interaction at a higher level, where the enterprise labor collective itself is responsible for the results of its own labor, both to domestic customers and to foreign business partners.

The procedure under which even the basic production links were cut out of foreign economic activity and specially authorized agencies dealt with all the details of that activity did meet the needs of the national economy at one time. But now that the volume of Soviet exports and imports of machinery has reached 35 billion rubles, now that it has acquired unprecedented dynamism and permeates all the basic branches, foreign trade brokerage is largely obsolete and often is a brake on scientific-technical progress, which was discussed quite openly at the 27th CPSU Congress.

In this connection, the improvement in foreign economic ties now underway in this country, improvement begun by party decision to increase their effectiveness, takes on particular importance. One avenue of this work is precisely that effort, to eliminate unnecessary tutelage and endow many production associations and enterprises with the rights and duties of broader participation in foreign economic activity, up to and including independent work in this area, while still preserving the socialist state monopoly in foreign economic ties.

But the reorganization has only begun, and deliveries are still being made under the former rules. What can be done to reduce these outlays to a minimum?

Working Without Claims

At the Moscow Chamber of Commerce and Industry, which serves the central oblasts of Russia, I met with Petr Mikhaylovich Mikhaylov, chief of the bureau of technical monitoring and expert appraisal for industrial equipment. He had just returned from Voronezh and was really annoyed at having to deal with the PTs claim.

"I hate claims. A claim is the last resort in foreign trade. Unhappily, though, because of the numerous intermediate links in the complex chain of foreign trade operations, there is slippage in the mechanism. It seems to me that this would be less often the case were our enterprises and institutions to contact the expert appraisal service not only in cases of dire necessity, but in the ordinary

course of events, working side by side with us through all the stages of importing equipment, from drawing up the contract to acceptance and transfer testing."

"But wouldn't that mean yet another tutelage link?"

"Until the new organizational forms have been established, no. We are not tutors, but rather fix up others' mistakes where we can. Our monitoring saves the state a great deal of money and could save it even more. But I'm sad to admit that the Chamber and our highly skilled specialists are late in getting involved in expert evaluation. Of course, it would be better still were each worker to do his own job well."

The Soviet Union imports tens of billions of rubles worth of machinery and equipment from other countries annually and ships many billions of rubles worth of equipment abroad in turn. Scientific-technical progress is making increasing demands on reciprocal deliveries of equipment, binding the partners to act in strict accord with the higher technical standards being stipulated in the contracts. This also concerns CEMA suppliers, especially in view of the fact that the genuinely equal and mutually advantageous relations among its participants leave increasingly less room for unfinished work as these relations are developed and offer increasingly broad scope for using the advanced experience already available.

The PTs-4 story necessarily draws attention to itself, if only because several other such automated centers have been bought for other domestic plants. Also, the story demonstrates what our own disorganization and depersonalization can lead to.

Lack of personal responsibility is a handy cover for numerous bureaucratic and personal mistakes, from laxity to connivance. In this instance, while the consignees of expensive equipment are ceaselessly and energetically looking for a way out of the situation, it is as if some foreign trade organization officials who are supposed to be looking out for those interests are waiting for the warranty to expire on that equipment so they can then "legally" disregard it.

In developing foreign economic ties, a very great deal has depended and will depend primarily on the competence of personnel at all levels, from the primary production link to the organization representing it in the world market. It goes without saying that the habit we occasionally see in some officials, of forgiving debts on the national account, is not tolerable in the least. That is disadvantageous to all the partners participating in the cooperation.

11052

CSO: 1823/37

INDUSTRY PLANNING AND ECONOMICS

INEFFECTIVE INSTITUTE ROLE IN RETOOLING CRITICIZED

Moscow EKONOMICHESKAYA GAZETA in Russian No 43, Oct 86 p 17

[Article by TASS correspondent M. Khabinskiy (Kharkov), exclusive to EKONOMICHESKAYA GAZETA, under the heading "Renovation: Design Quality": "Cheap Was Dear"]

[Text] Executives at the Ukgipromash [Ukrainian State Machine-Building Planning and Design] Institute in Kharkov have been called to strict account for developing a useless renovation plan for the Voznesenskiy Hydraulic Press Plant in Nikolayev Oblast. Chief engineer B. Sirota was dismissed. The director, B. Krivoshapka, and the project's chief engineer, Yu. Khokhlov, were severely reprimanded and that was noted on their party registration cards. The entire technical documentation package was rejected, and further construction and expansion of the enterprise was halted.

So an attempt to ram through an obsolete design in the guise of renovation was unsuccessful. But it is not the institute alone which is to blame. This plan was approved in routine fashion by the Minstankoprom [Ministry of Machine Tool and Tool Building Industry] and the USSR Gosstroy. It was only five years later, in May of this year, that a commission consisting of representatives of these organizations and the USSR State Committee for Science and Technology appraised it at its true worth during a grossly late expert evaluation. The State Committee for Science and Technology followed its customary rule of monitoring only very large projects, those costing 100 million rubles and up. The Voronezh plant renovation cost only...13 million rubles (which had almost all been spent), which the State Committee considered "minor."

The Kharkov obkom bureau used the conclusions of the commission, which included specialists in the field, to suggest that the institute, the ministry and the client jointly review the Voznesenskiy plant renovation plan within a month. Today, three months later, the matter is tangled up in all sorts of bureaucratic [plan] reconciliations. Moreover, the Ukgipromash leadership has been "able to reach agreement" with the ministry on postponing that review until December.

In spite of the complexity of the situation, the institute has done little to cut short this forced idleness. First, they were waiting for a planning program, which the Minstankoprom approved only last August. Then another three weeks waiting for a project review assignment. Ukgipromash representatives

did participate in preparing the documentation, but their partners were in no hurry. It now turns out that we need to be even more "patient," while the Voronezh Forge and Press Machine-Building Institute develops the technology for a future enterprise....

Prospects now seem to be brightening for the Voznesenskiy plant. It has been decided to re-specialized it. The original intention was for it to produce presses designed for the food industry. But when the construction ground to a halt, another enterprise had to begin producing that output. So it was decided to produce rotary conveyor lines for plastic items at the Voznesenskiy plant. That equipment would increase labor productivity many-fold and would be widely used in automotive-tractor, instrument-building and other branches of industry. Very promising. The intention is to begin producing these lines in 1989. The annual sales should be nearly double what was initially planned, with the same number of workers.

One can hope that the State Committee for Science and Technology will make a close expert evaluation of the design this time. For the time being, there are only promising computations: 80 percent of the equipment at the Voznesenskiy plant will be NPC machine tools, automatic lines, and flexible manufacturing modules and systems. The labor productivity planned will be significantly higher than the branch indicator targeted for the end of the five-year plan.

Design is a high engineering art requiring farsightedness, professionalism and the selection of nontraditional, optimal scientific resolutions. At the same time, "Ukrghipromash" associates have yet to evidence such qualities. After receiving an urgent assignment, they immediately pencil whatever equipment is available into the reinforced concrete "boxes" of the future shops. Progressive innovations are not sought by the designers.

After all, though, the Ukrghipromash's job is to set long-range technical policy for machine tool and tool-building enterprises of the Ukraine, Belorussia, Moldavia, the Transcaucasian and Central Asian republics, and a number of oblasts and krais of the Russian Federation. It is a role of some responsibility, but the institution has unfortunately gained a reputation as one not performing genuinely creative functions. Institute associates are credited with few inventions of their own, and they make poor use of those available. Links with the academy scientific research institutes and VUZ's are weak. The collective needs more skilled personnel.

After the June (1986) CPSU Central Committee Plenum and after the pointed, impersonal criticism at Kharkov obkom bureau and other party meetings, institute associates now understand that they cannot continue working this way. But they have been slow to re-order their thinking. No use at all is made of the experience of leading collectives. I asked institute leaders if they knew of the Leningrad experiment in stimulating the work of specialists.

"That doesn't apply to us," Ukrghipromash director B. Krivoschapka maintains.

The institute has drawn up a comprehensive plan of organizational-political, engineering-technical and economic measures. The document's intent is to mobilize. But what is it oriented towards? It anticipates, for example,

improving the skills of at least 100 people each year. It turns out that process will take until the end of the five-year plan. The document contains more general appeals and hopes than specific measures. This applies both to saving energy and to improving the ventilation and air-conditioning system, to improving the water supply and reducing the amount of metal used in structures.

What needs to be done to truly improve its design work? This question was put to leaders of the leading Kharkov institutes, invited on the recommendation of the party obkom to a roundtable discussion. After all, such lack of coordination is unfortunately also typical of other institutions in this field.

The participants noted the abundance of instructions, which restricts initiative and flexibility. We could also do without all the reconciliations [of plans], which sometimes take more than a year. One example: the procedure for developing planning documentation for direct-labor construction or major overhaul. It turns out that blueprints may be prepared with some flexibility, but in stages, the last sets of which can be issued just months before the project is to begin operation.

The ministries sometimes issue urgent design assignments, but the institutes doing this unplanned work are then "punished": the USSR Stroybank does not finance it if the work has not been agreed to in advance by superior organizations.

Institute specialists noted that they don't know how to "reconcile" their efforts to introduce progressive, future-oriented equipment into designs with the strict injunctions to propose for future enterprises only series-produced equipment which will be obsolescent when the project begins operating. One has to take a risk, to display personal boldness. But is not success sometimes achieved at too high a price?

Inequalities have developed between design institutes and the clients and builders. The former are obligated to economize, by lowering estimated costs, while their partners are interested in increasing costs so as to "pick up volume" and thus obtain greater profits and bonus monies.

The specialists were very critical of the State Committee for Science and Technology, an important monitoring agency. As of now, no clear normative criteria have been developed for the expert evaluation of finished projects, criteria that could be used to evaluate the economic effectiveness of the designed used.

Designers are the architects of scientific-technical progress. They must create for tomorrow, facilitating in every way possible the acceleration of the country's socioeconomic development. If not, situations like that at the Ugromash are inevitable.

11052

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IMPROVING 'TOOLS OF LABOR' STATISTICS

Moscow VESTNIK STATISTIKI in Russian No 3, Mar 86 pp 59-62

[Article by V. Gumenyuk, candidate of economic sciences, docent, Lvov Polytechnic Institute]

[Abstract] In order to improve the tools of labor in industry according to a plan, it is necessary to have available an appropriate statistical base. All tools of labor can be classified into five groups according to the number of machine stages Z and thus the number of manual functions these machine stages replace: hand tools ($Z = 0$), simple mechanisms ($Z = 1$), mechanized tools including production tools ($Z = 2$), machines without manual drive but also without automatic control ($Z = 3$), semiautomatic machines ($Z = 3.5$), automatic machines ($Z = 4$), and machines as components of a system controlled by a superstage without human intervention during manufacture of one product item ($Z = 4.5$) or of diverse product items ($Z = 5$). Auxiliary mechanisms only partly replacing manual functions count as a quarter of a machine stage ($\Delta Z = 0.25$). The average number of machine stages per worker is an index which characterizes the level of technical equipment available to labor, this index being $Z_p = 4.5 \cdot 8/2 = 18$ stages per worker in the case of 2 workers operating 8 machine tools with numeric program control by a computer with peripheral equipment or $Z_p = 3$ stages per worker in the case of one worker operating one universal machine tool. This index can be determined at any level of the production hierarchy. The level of mechanization and automation is then defined as the ratio $K_A = Z/Z_{\max}$ (Z --number of machine stages in service, $Z_{\max} = 5$ maximum number of machine stages) and the quantity $1-K_A$ represents the available margin of further improvement, by any of various means, of the tools of labor. The coverage of production processes by mechanization and automation is characterized by the factor

$$K_M = \frac{\sum_{Z=1}^5 m_Z}{m_{Z=0} + \sum_{Z=1}^5 m_Z} \quad (m_Z \text{--number of work stations with } Z \text{ machine stages,}$$

$m_{Z=0}$ --number of work stations with manual labor only). The degree of mechanization and automation is then characterized by the factor $K_{MA} = K_M K_A$. These three factors define the status of mechanization and automation of a production process. Not always accurately when calculated on the basis of weighted rather than numeral statistics pertaining to tools of labor, unless the utilization-time factor is also included. The next step in planning an improvement is forecasting the economic indicators, which must then be combined with those technical labor equipment indicators and production volume data. A governing principle here is that the cost of equipment increases with increasing number of machine stages. The flow of data for analysis and planning should be unimpeded, inasmuch as their acquisition and processing at every production level have already been organized for management purposes and no intricate accounting procedures need to be added. Tables 1; references 1: Russian.

2415/6091

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DEFINING TECHNICAL LEVEL OF DEVELOPMENT OF MACHINE MANUFACTURING ENTERPRISE
IN TERMS OF GENERALIZED INDICATOR

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 3, Mar 86 pp 64-67

[Article by Yu.T. Bubnov, candidate of economic sciences]

[Abstract] A generalized indicator describing the technical level of production in an enterprise is defined on the basis of partial indicators, their number being limited so as to ensure maximum accuracy and reliability of data processing as well as minimum volume of calculations. These partial indicators provide not only quantitative but also qualitative information about the development status of an enterprise, also a measure of progress in time. The generalized indicator then facilitates a realistic and practical interpretation of data as well as a comparative evaluation of similar enterprises. The partial indicators are best organized into hierarchical groups, all indicators in a group relating to some common production characteristic. Most influential in terms of increasing the production efficiency are active resources, their measurable components including power equipment and working equipment as well as tools and accessories in terms of state and utilization. Three groups of indicators, in the form of coefficients, characterize the basic active resources with regard to degree of replaceability, loading extensity (ratio of actual utilization time to planned utilization time), and loading intensity (ratio of actual production rate to certified productivity). These coefficients as well as indicators of other groups are determined on the basis of expert estimates or statistical analysis, whereupon they are weighted within each group for subsequent calculation of the generalized indicator. Factorial and regression analysis of annual production data in machine manufacturing enterprises, covering the 1968-82 period, have yielded an oscillatory progress curve in terms of the generalized indicator as a function of time over this 15-year period. Figures 2; tables 3; references 2: Russian.

2415/6091

CSO: 1823/193

DEVELOPMENT AND MANUFACTURE OF GENERAL MACHINE BUILDING PRODUCTS

Moscow STANDARTY I KACHESTVO in Russian No 5, May 86 pp 15-19

[Article by O.V. Yaremenko, Candidate of Technical Sciences, All-Union Scientific Research Institute of Standardization]

[Abstract] Products for general machine building use include materials or goods intended for use in machines, equipment and instruments in the machine building industry. This article suggests a classification of products for general machine building use and proposes principles to be used in the development of State standards and regulations for the development and manufacture of such products. The content and sequence of operations involved in the various stages of the life cycle of the product are noted, from the stage of determination of the need for a product through its development, manufacture and use. The responsibility of the developers for providing sufficient operational documentation of new products is noted. This article is presented as a suggestion, and reader's comments are invited concerning the need for the development of the principles and standards suggested here, as well as the actual content of the suggestions themselves. References: 2 Russian.

6508/6091

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METAL-CUTTING AND METAL-FORMING MACHINE TOOLS

UDC 621.9.06-113.004.14

IMPACT OF INCREASED USE OF SPECIAL AND SPECIALIZED MACHINE TOOLS

Moscow MASHINOSTROITEL in Russian No 8, Aug 86 p 21

[Article by engineer Ye. I. Kravtsov: "The Use of Special Metal-Cutting Equipment"]

[Text] One of the main factors which is lowering labor intensity and increasing labor productivity in machine building is the use of special and specialized machine tools.

In coal machine building where the main types of production are small series and series production and the product mix often changes, one has to be oriented, when ordering special equipment, toward specialized equipment which can be used on similar parts during a product mix change.

The PKTI [Planning and Design Technological Institute] (city of Donetsk) deals with the selection of a product mix to be machined on special machine tools and with the development of demands for these machine tools for coal machine building plants in coordination with Minstankoprom [Ministry of the Machine Tool and Tool Building Industry] plant demands and with the introduction of machine tools into production. By selecting special equipment, the institute is coordinating its specialized machine tools with machine tool plants to an overwhelming degree (up to 80 percent). Such machine tools as model 1B240-6, 1B265-6, and 1B290-6 horizontal six-spindle automatic lathes, model 1B240P-6, 1B265P-6, and 1B290-6 semiautomatic lathes; model 1K282 and 1B284 six and eight-spindle vertical semiautomatic lathes; model 2G942 milling-centering-turning machine tools; and special milling machines based on GF models and others belong to this category.

The most productive special machine tools, which machine a specific part, are also being ordered for Minstankoprom plants and are being introduced at coal machine building plants. Such equipment is being used when machining parts for large series or mass production.

For example, two special broaching machine tools, models MPZ-1039 and MPZ-1040, for machining turning cutter bit surfaces for coal combines have been introduced at the Krasnoluchskiy Machine Building Plant. The availability of loading devices with the broaching machine tools has permitted the introduction of multiple-machine tool maintenance, an increase in labor productivity, the freeing up of two machine tool operators, and the realization of a yearly economic impact of around 100,000 rubles.

A special model AM 13617 vertical 12-spindle drill press with a three-position swivel table for drilling holes in a plate and lining has been introduced at the Kamenskiy Machine Building Plant imeni the 50th Anniversary of the Soviet Ukraine. The simultaneous machining of one plate and two linings has permitted a 4-fold decrease in machining labor intensity and the freeing up of two machine tool operators.

A special model AB 2192 aggregate vertical open-side machine tool with a guiding device on a swivel spacing table and with one horizontal adapter was introduced at this same plant on a line for machining hydraulic support cylinders. Several operations which had been carried out on universal lathes: milling lug surfaces, drilling holes, counterboring, reaming and cutting thread, were combined on this machine tool. The separate machining of the surface and holes has led to a violation of the plan's requirements for the perpendicularity of the axes of the holes to the surface of the lug. The shift of these operations to an aggregate machine tool has provided the steady fulfillment of this technical requirement. The introduction of such a machine tool has permitted a two-fold decrease in machining labor intensity, the freeing up of four universal lathes (including three vertical drilling ones with numerical control), three machine tool operators, and an annual economic impact of more than 150,000 rubles.

Three aggregate drill presses, models 3KhG5954P, 3KhG5994P, and 3KhG5995P, were introduced for machining slip joints in connecting pipe, T-joint, and lug parts at this same plant. The parts are mounted on guiding devices fastened to a swivel table. Machining is carried out by one- and two-spindle horizontal and vertical heads, using two-stage counterbores. As a result, machining labor intensity has been decreased 6-fold, six universal lathes have been freed up, and an annual economic impact of 127,000 rubles has been obtained.

The main thing when introducing special and specialized machine tools is the achievement of an economic impact from their introduction. Minstankoprom has developed and confirmed a new method for calculating the economic impact from using special machine tools (the regulation "Determining the Economic Impact from the Production and Utilization of New Special (including Aggregate) Machine Tools and Automatic Lines." Minstankoprom, ENIMS/Experimental Scientific Research Institute of Metal-Cutting Machine Tools/, 1983). Calculations by this new method have yielded fuller results and made it possible to more widely use special machine tools in coal machine building.

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METAL-CUTTING AND METAL-FORMING MACHINE TOOLS

NEW MATERIALS, TECHNOLOGY FOR FMS SYSTEMS, MACHINE TOOLS

Minsk NARODNOYE KHOZYAYSTVO BELORUSSII in Russian No 8, Aug 86 pp 30-31

[Article by Yu. A. Starostinetskiy, manager of manufacturing at the Minsk Special Design Bureau for Broaching Machines: "Scientific and Technological Progress: Pace, Incentive and Control. Catch Up? No, Surpass!"]

[Text] The widespread introduction of flexible automated manufacturing systems and facilities is only possible through the use of modern equipment. The problem requires a comprehensive solution which incorporates the creation and use of new and promising materials. For machine tool construction these materials should provide corrosion protection, increased wear resistance and improved antifriction properties. In this article Yu. A. Starostinetskiy, manager of manufacturing at the Minsk Special Design Bureau for Broaching Machines, discusses these materials and why they are so slow in coming to production.

You don't grease but you will eat

Machine tool reliability depends to a great extent on friction forces. Special metals and alloys based on scarce nonferrous metals (tin, lead, copper) are used to increase machine tool efficiency and antifriction properties. Nevertheless the use of lubricants cannot be avoided.

To be sure, antifriction materials such as filled fluoroplastics and epoxy and dianil resin-based polymer coatings or compounds are being used today, although in very limited quantities. They improve friction force operating characteristics and significantly reduce manufacturing labor requirements.

The advantages of fluoroplastics and polymer coatings are their anti-galling properties and a capacity to operate for limited periods without lubrication. The operating time is limited because both the fluoroplastic and polymer coating are subject to severe wear. For this reason the concept of a lubricating system will continue to have a place in the machine tool. Any such system requires labor for its manufacture and operation and can be a source of surprises on the job. More modern self-lubricating materials are needed to replace traditional ones.

At first glance there is nothing amazing about the closely woven, dark-brown cloth. It's hard to believe that using it to cover friction surfaces can cause a significant increase in service life between rebuilds and a reduction of vibration and noise levels. Mind you all this is taking place under dry friction conditions, without a lubricant supply. It also brings with it a significant reduction in metal requirements and a sharp reduction of expenditures for routine maintenance. This cloth was developed by the Rostov State University Physics and Organic Chemistry Scientific Research Institute and is called the self-lubricating organic fiber plastic. It can be attached with an adhesive to metal, plastic, ceramic or almost any other material. The covering thickness is 0.2 to 1 millimeter.

A brief description of this cloth attracted the attention of Planning and Technology Department workers at the Minsk Special Design Bureau for Broaching Machines. However, it seemed that no one had used organic plastic fibers on machine tools. Brief hesitation here gave way to enthusiasm. This was all the more interesting!

Tests at the Minsk Automated Lines Plant using the self-lubricating organic fiber plastic on circular saw spindle head slip supports allowed an unequivocal decision to be made: give the product its "start in life." The machine tool was shipped to customers with the caveat that it required special monitoring.

A 1-1/2 year operating period is not a long time but it was enough to dispel many doubts. Machine tools with antifriction cloth coverings can be found in Minsk, Zhodino and Tula. Self-lubricating organic fiber plastics are crowding out the widely known and popular metal/fluoroplastic coatings.

But the use of innovations on individual machine tool models doesn't solve the problem. Widespread introduction involves problems on the psychological level in addition to organizational and technological considerations. What counts here is that habit is oriented toward what has already been proven in practice by others rather than toward innovation. After all, the adoption of domestic experience and achievements by foreign firms is a natural and necessary process. The situation is bad, however, when initiative is completely excluded in favor of this process of adoption. Instead of fundamental objections, when introducing one concept or another the specialist often hears the rather banal question, "Who is using it?" The psychological barrier set up if the answer is no one or if the user is not a prestigious firm often cannot be overcome.

This brings to mind a conversation with the chief production engineer of a machine tool plant. He did not listen to my proof of the efficacy of the self-lubricating cloth because he was excitedly telling me about the "black plastic tape" that was being used on friction surfaces. He had seen it at a Leningrad enterprise. Closer questioning revealed that he was thinking of a filled fluoroplastic, a rather widely used material whose qualities are far surpassed by the self-lubricating cloth. Unfortunately, it was impossible to change this chief engineer's mind. He was under the influence of the prestige provided by a plant known throughout the country and was obviously also afflicted with a fear of innovation.

At times products developed by foreign firms are considered perfect. We prefer them and convince ourselves that our own experience is not as up to date. Although initiating is never easy, following always means trying to catch up. While this is explainable and justifiable in many cases from a tactical point of view it can never be permitted as a strategy.

The BSSR Academy of Sciences' Institute of Metal Polymer System Mechanics (IMMS) is also working on the development of self-lubricating antifriction materials (SAMs). These materials are processed into products by means of pressure die casting on standard equipment (automated thermoplastic units and foundry presses). Although only 10-30% more expensive than basic thermoplastics filled with reinforcing agents, dry lubricants and other components, SAM operational characteristics are 5-10 times greater. A wide range of physical and mechanical characteristics can be obtained through various additives. It is becoming clear that SAMs are worthy of widespread introduction in the republic's machine tool building enterprises. However, you can be sure that many people are not familiar with the material.*

Of course, knowing about the innovation doesn't solve everything. There must be energy and perseverance in allocating assets and conquering the psychological barrier. First of all, however, there must be knowledge and the dissemination of necessary information. Scientific research institute personnel must become better at this. They do not put enough effort into publicizing their innovations. Information can be heard at symposia or conferences in rooms filled with scientists. In my opinion researchers must have more meetings with design organization personnel and factory shop engineers.

Proven in practice

When examining ways of increasing friction surface wear resistance we must not forget the as yet little-known process of surface epilamination. "Epilama" is a surfactant film. When used to cover a component's working surface it provides high wear resistance, lowers friction, prevents the formation and spread of microscopic cracks caused by dynamic loads and improves lubricant retention. All this is done by a film which is only a few dozen angstroms (millionths of a millimeter) thick.

The epi-lamination process is surprisingly simple. The component is degreased, placed in the epilamination unit and held there for 5-7 minutes. After drying its surface wear resistance is increased severalfold. The compound can also be applied with a pad or brush.

* BSSR Academy of Sciences' IMMS personnel V. Savkin and V. Struk have filled this gap. Their article "SAM cmazyvayet sam" [SAM Lubricates Itself] was published in the previous issue.

There are two examples of a complex metal-cutting tool, the broach, in front of us. Both have been in service but they look different: one has clear signs of wear and chipping is evident on the tooth surfaces while the other looks as though it has hardly been used. The reason? The second was treated by epilamination.

Knives, drill bits, milling cutters, hobs and gear cutters represent only a fraction of the tools on which the process has proven effective by achieving a 2 to 4-fold increase in dimensional tool life. Epilamination produces excellent results on machine components, even non-metallic elements. The wear resistance of rubber wheels processed in the boiling compound is increased more than fivefold.

As established, epilamination significantly stabilizes the movement of the supports, rams and tables which serve as guides on metal-cutting machine tools and provides a severalfold increase in the accuracy with which they arrive at their assigned positions. This is a very important consideration, especially in NC machine tools.

All this has been proven in practice. When informed of the innovation by some of our Planning and Technology Department's workers a substantial special design bureau at one of the machine tool building plants was at first wary. Everything went at its own pace. Their job was to test and ship machine tools. Accuracy values are to be within standards. Guide wear? What guide wear? Is it supposed to show up in a few hours of testing? No, that happens out there at customer sites.

Wait a minute! What about this lathe? It's a special machine with numerical control. It is subject to one requirement in addition to all the normal ones: stable processing of the control signal and accurate support positioning. The required stability was not being achieved. The spread of values was far in excess of permissible tolerances. A repeated suggestion for the use of epilamination was met with great attention. After this was carried out careful measurements showed that positioning stability was increased severalfold.

To be honest, in this case the machine tool builder's doubts were justifiable to some extent. What would happen to this thin surfactant coating during the friction process? The surface does experience some wear, even if it is only slight. Remember that even a thousandth of a millimeter of wear is equivalent to 200 layers of the film.

We gave the problem to researchers and they achieved practical results. One thing is clear, epilamination is producing a tremendous impact and its scope of application continues to increase. This is no trivial detail

The metal-cutting machine tool is a tireless worker which is always subjected to the effects of shear forces and vibration. Just think of the number of lockwashers, jam nuts, pins and components of all types which are undergoing vibration! Furthermore, not all of them can go forever without failing.

One or two drops of a greenish, viscous fluid are applied to the threads of a screw, then the nut is installed. Several dozen minutes later and the threaded connection is equal to, and sometimes even stronger than, a solid connection. While retaining its ability to be removed, the connection can withstand heavy dynamic loads. Its reliability has even been proved on special vibration stands run by automobile manufacturers.

What is this fluid? It's an anaerobic adhesive sealant. This means that it polymerizes when not in contact with oxygen in the air. A good ability to penetrate allows it to completely fill the space between the components to be joined and to cover micro- and macro-irregularities in their surfaces. This provides a tight connection and the required mechanical contact between components.

The anaerobic adhesive sealants can be used at temperatures ranging from -60 to +150 degrees C. Depending on the adhesive type and purpose the maximum gap to be filled can be up to 0.45 mm. They can be used in the presence of oil, fuels, gases and emulsions and can withstand working pressures to 300 atmospheres.

The Unigerm and Anaterm adhesive sealants were developed by the Polymer Scientific Research Institute (in Dzerzhinsk, Gorkiy Oblast). The adhesives are available in air-permeable polyethylene containers and in microcapsular form (in a gelatinous casing). For example, the powder-like microcapsules can be applied to threads where they break up when the connection made and release the adhesive which fills all gaps.

Adhesive sealants are being used for hydraulic and pneumatic system connections in machine tools and automated lines and to seal non-moving joints in reduction gearboxes, spindles and other units. They have also found yet another very important application in adhesive powder compounds where they eliminate macrodefects occurring during casting and machining. Compared to the epoxy resin materials normally used, these compounds are providing a several-fold increase in defect elimination thanks to their practically nonshrinking and very rapid polymerization. They have provided an effective alternative to defect soldering and welding by assuring not only a good seal but high mechanical resistance as well.

Some types of adhesives are also used as antiporing agents used to impregnate welded seams and casting pores in order to assure a good seal. Work is underway to improve existing products and create new types of high-strength adhesives to replace traditional means of mechanically connecting components, including those subjected to heavy working loads.

Modern machine tools, automated lines and robotized complexes are extensively equipped with hydraulic functions. This means they are fitted with piping systems. We all know how much effort is needed to prepare pipes prior to installation and use. The flexible polymer hoses used in machine tool building around the world and assimilated in this country by the Plastik Scientific Production Association in Moscow are of interest here. The association produces two types of hoses, a low-pressure (polyvinyl chloride) and a high-

pressure (polyamide) type. The introduction of polymer hoses achieves more than just oil purity in hydraulic systems, it leads to more interesting types of machine tool equipment with lowered requirements for metal.

The quality of modern machinery, including metals machining equipment, is determined by esthetics as well as by functional performance values. Look at the appearance of machine tools. They are covered with all types of logos and data plates made of sheet metal, duralumin and other metals, placed at all angles and fastened with far-from-esthetically-pleasing rivets and screws. Some plants, to be sure, have introduced plates attached with adhesives, but their external appearance has not improved and in some cases has worsened.

These labels should be replaced by decals. With their richly colored graphics and typography on a polyethylene terephthalate film, decals improve a machine tool's outward appearance and reduce labor and metal requirements.

We have limited our analysis to just a few of the resources derived from the introduction of new materials. It is hoped that the listing will point out the range of possibilities offered by these new materials and the degree to which they are replacing obsolete technical solutions. All that is new and progressive must be introduced into production more rapidly. Even the smallest delay can put us behind. What happens then? Catch up once more?

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12746

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METAL-CUTTING AND METAL-FORMING MACHINE TOOLS

GEORGIAN TOOL INDUSTRY EXCESSIVE EQUIPMENT OVERHAULS

Tbilisi ZARYA VOSTOKA in Russian 30 Sep 86 p 2

[Article by deputy head of machine building department, Georgian SSR Gosplan, Levan Turmanidze and head of machine building and metal processing sector, NII [scientific research institute] of economics, planning and management under the Georgian SSR Gosplan, Avtandil Chachibaya, under the "Reserves for Intensifying Economics" rubric: "These Endless Overhauls of Old Machine Tools and Equipment Cost The State Too Much"]

[Text] Capital productivity in machine building industry diminishes, whereas basic funds are growing at a considerable pace. In 1981-1985, basic funds increased by 57.4%, whereas capital productivity decreased by 23.3%. These numbers should call attention. They become understandable, if one takes into account the fact, that insufficient pace in replacing machines and equipment with more progressive types has caused moral and physical obsolescence in a large number of sectors of the republic machine building industry.

The directive rate of removal of basic production funds in machine building industry is 7% per annum, which will make it possible to completely renovate them in 15 years. But for a number of years, this rate has been decreasing, whereas renovation periods have even lengthened. In 1980, the actual rate of removal of basic funds was 2.5% instead of 7%, and for machines and equipment it was only 1.6%, whereas in 1985 these figures were 2.3 % and 1.6%, respectively, i.e. these indices tend to stabilize. Simple calculations demonstrate, that instead of 15 years, machines and equipment will be actually replaced only in 42 years.

Data on age structure of machines and equipment demonstrate accumulation of physically and morally obsolete equipment. For instance, at Tbilisi machine tool building production association, metal-working machine tools that are more than 20 years old comprise 43.7% of the fleet. In assembly and machine shops of the association, a horizontal drilling machine has been working since 1937, an SM-132 steam-air forging machine has been working since 1949 etc. At Tbilisi machine building plant imeni Ordzhonikidze, 17 screw-cutting lathes, model 1K62, have been working since 1960, four gear-hobbing machines have been working since 1962; at Tbilisi machine building plant imeni 26 commissars, two centerless grinders have been in operation since 1947, 25 screw-cutting lathes have been in operation since 1958 etc. All in all, 280 pieces of metal-

cutting machine tools are installed at the plant, and 107 pieces, or 38.2%, are physically and morally (sic) obsolete.

At present, in Georgian machine building industry only 1.6% of machines and equipment are replaced, 0.7% are modernized and about 16% undergo overhauls. Due to moral and physical obsolescence of production equipment, actual expenses for overhauling machines and equipment in 1981-1985 amounted to 66 million rubles. This would have been enough to reequip 15 plants, such as Tbilisi tool building plant or four production associations, such as the machine building association.

Overhaul expenditures per ruble of average annual basic funds in the republic machine building industry were 3.9 kopecks in 1980 and 3.5 kopecks in 1985. Stabilization of the expenditures is due to a large extent to the need for maintaining physically worn-out machines in working order.

So far, economic incentives that would encourage propagation of scientific and technical innovations, displacement of old equipment and related inefficient technology by highly productive machines and equipment and principally new production tools, are weak.

In 1986-1990, production volume of the republic machine building industry will increase by a factor of 1.7. Sectors of the machine building industry, that play a decisive role in accelerating technical progress, will be expanding ahead of others. In order to further increase intensification of industrial production in the republic machine building industry, an important role is to be played by dissemination of Leningradians' initiative: use new and progressive portion of production funds two or three shifts and thus fulfill the 12th Five-Year Plan, whereas remove obsolete equipment from production and use the freed-up space for organizing modern production. Considerable reduction of new construction will make it possible to decrease capital investment for these purposes. Part of saved money could be used for integrated solution of technical and economical, as well as social problems. It was emphasized at the 3rd Plenary Seating of Georgia CP Central Committee, that the republic has the richest capabilities for disseminating Leningradians' initiative, because even at the most advanced enterprises shift ratio does not exceed 1.3. It was also noted at the Plenary Seating, that new capacity must not be created at those enterprises, where the possibilities of organizing two-shift operation of already existing capacity have not been exhausted yet. Wide application of multi-operational equipment, CNC machine tools and flexible modules form a technical basis for development of machine building industry in the 12th Five-Year Plan.

12770

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SELECTING PRODUCTION-EFFICIENT MODES OF TOOL OPERATION FOR ROUGH MACHINING ON HEAVY AND LARGE LATHES

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 3, Mar 86 pp 40-44

[Article by G.L. Khayet, candidate of technical sciences, M.G. Kotkina, candidate of technical sciences, and Ye.G. Sidorenko, engineer]

[Abstract] A method of selecting the most production-efficient modes of rough machining is outlined, specifically applicable to rough machining of steel parts with maximum diameter 1250-4000 mm and 800-1000 mm on respectively heavy and large lathes of corresponding sizes. The problem is formulated as an optimization problem, of extremizing a set of target functions under certain constraints: minimizing the production time and thus maximizing the productivity at a fixed specific tool utilization $R = 1/1000KTvs$ pieces/mm² (K--mean tool life counted in number of periods of stable performance before resharpening till depletion, T min--mean resistance of tool in terms of wear time, v m/min--cutting speed, s mm/rev--feed rate) for producing a given number of pieces with a given number of tools. The variable component of the referred cost A_{var} kop/mm² and the variable component of the referred piece production time t_k min/mm² are selected as target functions, both depending on the cutting process parameters v, s, T and on the mean tool replacement time but the referred cost A_{var} also depending on four cost factors. These factors are the per-minute cost of main and auxiliary operations, including repair and depreciation as well as return on investment, the net cost of a tool and the cost of tool resharpening. The optimization problem is solved on the basis of known relations and empirical data, graphoanalytically in the s-v plane. It is solved specifically for a model 1A665 lathe with a T15K6 cutter, using data on machining parts made of structural steel with Bhn = 210 as reference base. An analysis of the dependence of the relative economical cutting speed and feed rate on the four cost factors and the mean tool replacement time, with each of them separately varied from half to twice its reference base and all other held constant, reveals that the optimum feed rate depends most strongly on the tool cost and the optimum cutting speed depends most strongly on the mean tool replacement time. As the tool cost increases, the optimum feed rate decreases and production losses are minimized by an increase of the cutting speed. As the mean tool replacement time increases, the optimum cutting speed decreases and production losses are minimized by an increase of the feed rate. In addition is established the dependence of the tool resistance or wear time T and of the tool life or resharpening periodicity K, optimum according to the various economic performance criteria, on the part diameter and the corresponding lathe size. For refinement of the analysis are also included empirical correction factors for cutting speed and feed rate as functions of production requirements, plotted in the form of nomograms. Figures 5; references 8: all Russian.

2415/6091

CSO: 1823/193

CUTTING PORTIONS OF TOOLS FROM STANDARDIZED BLANKS

Moscow MASHINOSTROITEL in Russian No 4, Apr 86 pp 17-19

[Article by Candidate of Technical Sciences V.N. Konoplev]

[Abstract] A new trend in machining is to make the cutting plates of many different tools of thin layers of high speed steel in standard shapes. A relatively small number of such standard-shape cutting plates can be used for a large variety of machine tools. When worn, the cutting plates can be replaced easily, effectively producing a new cutting tool. The standardized cutting plates can be made from an even smaller number of high speed steel blanks, each of which serves for manufacture of cutting plates with geometrically similar shapes and a small range of dimensions. Standardization of high speed steel blank types allows the creation of standardized technological processes for manufacture and assembly of large cutting tools. Figures 5.

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INFLUENCE OF RELATIVE TOOL-BLANK OSCILLATIONS ON EFFECTIVENESS OF USE OF
MODERN CUTTING MATERIALS

Moscow STANKI I INSTRUMENT in Russian No 4, Apr 86 pp 24-26

[Article by A.L. Vilson, R.V. Iordanyan and A.D. Shustikov]

[Abstract] A study is made of the influence of relative oscillations between cutting tool and surface being worked in the radial direction on the life of tools made of modern cutting materials, and to establish the maximum or critical oscillations for which the use of such tools is effective. Tools studied include hard alloy tools with wear-resistant coatings and ceramic tools. Studies were performed under cutting conditions recommended for rough and semifinished working of cast iron. The test stand included an oscillator with feedback and automatic gain control to maintain the specified oscillating conditions. Figures illustrate tool wear as a function of oscillation amplitude, and equations are presented for determination of tool life as a function of the amplitude of relative tool-workpiece oscillation. Figures 4, references 4: Russian.

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INDEPENDENT DEVICE FOR PREPARATION, MONITORING AND DIAGNOSIS OF PUNCH TAPES
FOR NUMERICALLY CONTROLLED MACHINE TOOLS

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 7, Jul 86
p 10

[Article by Doctor of Technical Sciences Yu.S. Sharin and Engineer B.V.
Vershinin]

[Abstract] The Urals Polytechnical Institute imeni S.M. Kirov, in cooperation with the Magnitogorsk Metallurgical Combine, has developed and begun manufacture of a specialized device for preparation of data on punch tapes, consisting of a YeS-9024 data preparation device and a type VT-340 alphanumeric display, which increases the reliability and speed of operation and allows visual monitoring of the text to be punched on the tape before the tape is produced. Data to be punched are first keyed into the display unit, then the SEND button is pressed and the data are punched on the tape. Introduction of this device has reduced the time required for production of punch tapes for numerically controlled machine tools, reducing machine tool downtime and improving productivity. No figures for cost savings are presented. Figures 2.

UDC 62.229.6:621.863

AUTOMATION OF LOADING OF METAL-CUTTING MACHINE TOOLS

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 7, Jul 86
p 11

[Article by Candidate of Technical Sciences V.P. Bobrov]

[Abstract] When plants are automated, one should consider the valuable experience gained in the Second World War in the Soviet Union, rather than basing all plans on the use of robots. This article describes briefly some of the experience gained in the Soviet Union in the 1940's, including the use of sloping troughs to hold parts to be loaded into machine tools. These troughs, it is said, not only utilize reliable gravity flow, thus reducing problems, but also provide a ready means for storage of parts awaiting their turn to be machined. Gravity troughs, simple pushers and other mechanical devices are many times cheaper than robots, and are also quite reliable and easy to maintain.

OPTIMIZATION OF CONTROL PROGRAMS FOR NUMERICALLY CONTROLLED MACHINE TOOLS

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 7, Jul 86
pp 13-14

[Article by Candidate of Technical Sciences M.A. Levin]

[Abstract] The quality of control programs used for numerically controlled machine tools is determined by manufacturing a test batch of parts. This experimental stage can be eliminated by testing the control programs as they are developed. The suitability of control programs for use on a machine tool can be estimated by determining the agreement of the quality parameters with the requirements of the design and technical conditions of the parts being manufactured. The quality parameters depend on the technological conditions selected. An algorithm has been developed for optimizing control programs, utilizing files of functional and criterial limitations, plus the values of the radius of curvature of cutting tool tip, tool life and the actual time of operation of the tool. The algorithm and program for optimization of control programs were developed and implemented at Sevastopol Instrumentation Institute on an Elektronika DZ-28 microcomputer. Utilization of the new program achieves a savings of 120 rubles per part type designed.

6508/6091

CSO: 1823/323

OTHER METALWORKING EQUIPMENT

BENEFITS, APPLICATIONS OF DIAGNOSTIC INSTRUMENTS VIEWED

Moscow MOSKOVSKAYA PRAVDA in Russian 13 Nov 86 p 3

[Article by TASS reviewer V. Belyayev and response by Doctor of Technical Sciences F. Sosnin, Deputy Director General of the Spektr MNPO (machine-building scientific-production association), under the heading "Attention: Experience": "Devices That See and Prevent"]

[Text] The "Izhorskiy zavod" association has studied the most important assemblies and parts of the "5000" sheet mill, which can produce sheet and plate about 5 m wide and up to half a meter thick. After a year of operation, this unique unit was studied with ultrasonic and magnetic diagnostic instruments which confirmed the reliability of the mill's main assemblies, many of which were manufactured for the first time in our country, as a TASS correspondent reported from Leningrad.

The X-ray, ultrasound, fluorescent and magnetic-particle flaw detection instruments now being used in industry, construction and transport are all non-destructive monitoring devices (SNK) of proven effectiveness. They permit a 15-20 percent reduction in product materials intensiveness and a 50-percent increase in product durability. These are averages. The following are some specific examples.

After introducing a non-destructive monitoring unit, the Chelyabinsk Metallurgical Complex was able to reduce losses of primary output by 8,000 tons. The time needed for rolled metal quality control was cut from 8 hrs to 1-5 minutes. As a result, more than 120 inspectors were freed for other jobs. The use of SNK at the "Daldizel" plant in Khabarovsk cut defects by 50 percent. The introduction of active monitoring at the Gorkiy Automotive Plant permitted a 200- to 300-percent increase in labor productivity in some operations, and defects were reduced by 75 percent.

X-ray and ultrasonic flaw detection instruments at the "Nasosenergomash" association in Sumi have been added to the receiving line, so to speak, for castings and die forgings arriving from suppliers under cooperative agreements. Thanks to this, practically no defective blanks reach the machine shops. Were such monitoring done conscientiously at the casting and die forging manufacturers, pointless transport outlays could be avoided as well.

If only! This cry is often heard when some misfortune which could have been averted befalls a person or a collective. If only the tractor engine plant in Kharkov had made skillful use of active and non-destructive monitoring devices. If only the microcracks in the diesel engine blocks and several other important parts had been discovered in time. If only that were done, defects in a total of 840 SMD-62 engines for Kharkov T-150 tractors would have been discovered at the plant. Incidentally, it is 10 times cheaper to correct defects at the manufacturing enterprise than for the customer to do it.

The effectiveness of using SNK is obvious and requires no additional proof. One would think the associations and plants of machine-building and metallurgical industry in particular would long ago have begun making extensive use of these progressive methods of flaw detection. In fact, there is a lot of sincere talk at all these enterprises about the necessity of improving product quality, a lot of promises about surpassing the best foreign analogs. A Gosstandart [State Standards Committee] check of 211 plants in five ministries showed that active and non-destructive testing is being done on a very modest scale. Why?

The Belorussian Standardization and Metrology Center, which was designated the lead organization for state SNK testing several years ago, provides the answer. Some useful and curious research has been done in Minsk. SNK increases the labor intensiveness of monitoring somewhat, reveals shortcomings in technology, increases losses due to defects, and demands greater production discipline. Not everyone likes helpers of this kind. They are also sometimes inhospitable to those who talk loud and long about the necessity of improving product quality. Is that not why more than 70 SNK units were taken out of seven enterprises of the Ministry of Machine Tool and Tool Building Industry and the Ministry of Automotive Industry last year?

In this connection, we must not fail to call attention to one other circumstance of some importance, one that was discovered by Gosstandart specialists, or more accurately, by the Belorussian Center, which analyzed 598 GOST's [All-Union State Standards] for finished products. It turned out that 313 (52.5 percent) did not stipulate the use of any active or non-destructive monitoring. Some standards permit using SNK. In other words, production organizers are rejecting the use of devices and methods which promise to relieve manufacturers of some grief and misfortune, and they are doing so voluntarily, without coercion, and in the very early stages of manufacturing machinery and mechanisms.

The development, approval and implementation of a standard is a long and relatively complex procedure. Significant numbers of scientists and specialists are involved. State and branch normative-technical documents are ordinarily drawn up by qualified people. Yet quality control methods are sometimes represented by blank spaces in many GOST's and OST's [All-Union Standards]. At the same time, quality control is properly a common technological operation in the overall process of manufacturing a product. Disregarding such operations has never promoted the production of well-made items.

The interests of improving product quality and of saving materials and labor demand the more extensive use of SNK. We obviously need to begin by increasing the effectiveness with which those non-destructive testing instruments already available in the national economy are used. At the same time, instrument

manufacturers and their suppliers are faced with making efforts to put SNK production on the leading edge of scientific-technical progress.

[Response] Modern non-destructive monitoring is among the most important technologies capable of ensuring speed, quality, technical sophistication and economy. Relative expenditures on it comprise part of the product cost, a minimum of 1-3 percent of the cost of manufacturing ordinary items, for example, five percent of the cost of manufacturing welded connectors, and 10 percent of the cost of manufacturing gas pipelines. However, these expenditures are immeasurably smaller than the cost of the losses possible. Disregarding the diagnostic information generally leads to serious consequences.

The leaders of many Moscow enterprises understand that non-destructive monitoring expenditures are recompensed very quickly. At the ZIL [automotive plant], a large number of automotive parts are checked for such parameters as rigidity, heat treatment quality, discontinuities, and other defects with the help of optical, magnetic, thermal, X-ray and physical SNK methods. This improves the quality of the vehicles and reduces the labor intensiveness of the monitoring operations, substantially improving the work standards of the inspectors operating the SNK equipment and making their work easier.

The Moscow Pipe Plant uses SNK units for flaw detection on the production line. The units reveal various pipe defects and determine their physical and mechanical parameters (rigidity, strength, heat treatment quality) at a rate of up to three meters per second. The economic impact of introducing this equipment exceeds 100,000 rubles per year.

Why hasn't SNK received an "all-points pass" in Moscow then? In addition to the inertia of individual administrators, there are also organizational reasons for the slowness in introducing effective monitoring equipment.

We need to achieve a situation in which all the specifications and assignments for developing new machinery are obligated to include a section on "Diagnostics and Testing Methods and Equipment." Quality control and diagnostics devices must be incorporated in the standards as basic technological equipment for the production and operation of any type of output. These same documents should increase the responsibility of product developers and manufacturers for the diagnostics accompanying production and operation technological processes.

Gosstandart normative documents need to institute a procedure whereby diagnostic equipment is developed along with the item, in parallel, at the same time, and not, as is often the case, sequentially and following mishaps, to ensure that requirements for developing monitorable assemblies and parts are followed, from microelectronics to the buildings housing free-standing nuclear reactors and other large facilities.

11052

CSO: 1823/50

OTHER METALWORKING EQUIPMENT

THE POWERFUL PRESSES OF VORONEZH

Moscow NAUKA V SSSR in Russian No 3, Jan-Feb 86 pp 20-25, 96

[Article by A.T. Kruk, General Director, Voronezh Heavy Mechanical Press Production Association, I.N. Filkin, Candidate of Technical Sciences, Chief Designer and V.N. Tynyanov, Candidate of Technical Sciences, Department Chief]

[Abstract] In 1984, a group of workers at the Heavy Mechanical Press Production Association in Voronezh were awarded USSR State prizes for the creation and introduction to the national economy of heavy and unique mechanical presses and automatic production lines and system based upon these presses. This article presents a popularized description of the process of manufacture of metal parts by pressure rather than cutting and of the heavy mechanical presses used for this purpose. Photographs of such monsters as a 125 MN press for hot stamping of 160 kg crankshafts and a press for stamping of 9 to 12 meter long truck frame members are presented. The heavy mechanical press production association has now completed the transition from manufacture of individual specialized machines acting independently of each other to the creation of complex automated systems of machines, which represented some 60 percent of total production in 1985 at the plant. The operation of such a complex is briefly and popularly described. Specific equipment type numbers are not given with the presses described and illustrated.

6508/6091

CSO: 1823/251

LASER WORKING OF HARD ALLOY BLANKS

Moscow MASHINOSTROITEL in Russian No 4, Apr 86 pp 24-25

[Article by Doctor of Technical Sciences V.S. Kovalenko and Candidate of Technical Sciences V.P. Dyatel]

[Abstract] Kiev Polytechnical Institute has suggested making centered apertures 0.6-1.0 mm in diameter and up to 6 mm deep, as well as penetrating apertures for wire electrodes 0.3 mm diameter, in blanks up to 10 mm thick by laser radiation using the "Kvant-16" 30 Joule laser installation. The use of laser radiation in the manufacture of centering apertures which have complex contour and must be made in two passes, and penetrating apertures in parts of hard alloy, increases the productivity of the process by a factor of 10 to 20 in comparison with electric pulse working. Figures 2.

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COMPETITION RESULTS FOR INNOVATIVE POLYMER MATERIAL PROCESSING EQUIPMENT

Moscow MASHINOSTROITEL in Russian No 8, Aug 86 pp 40-41

[Article by Candidate of Technical Sciences and Chairman of the section on the processing and use of polymer materials in machine building M. G. Dranovskiy and L. N. Novichkova: "Competition Results"]

[Text] The all-union competition "for better work in developing new types of equipment, accessories and instruments for processing polymer materials, aimed at decreasing import purchases" was conducted in 1985 by the Central Board of the NTOMashprom/scientific and technical society of the machine building industry/. Its purpose was to attract scientists, specialists, engineering and technical personnel, and innovative workers to the solution of the problems of intensifying the production of machine parts and instruments made of polymer materials and saving material and power resources during their processing.

In accordance with the results of the competition, the presidium of the TsP [central administration] of NTOMashprom awarded a diploma and the first monetary prize of 800 rubles to the work "Research on and Development of Equipment, Material, and the Technology of Manufacturing and Introducing into Machine Tool Building Plastic Electrical Mounting Perforated Boxes which Increase the Quality of Machine Tools and Improve the Working Conditions of Laborers," which was conducted by members of the NTOMashprom NPO/scientific-industrial association/ of ENIMS/Experimental Scientific Research Institute of Metal-Cutting Machine Tools/ V. Ye. Bart, A. Ye. Kuvardin, B. P. Gorynshin, and S. A. Shevchuk. The authors solved a whole set of scientific research and design problems in creating specialized and casting equipment. They selected polymer materials possessing manufacturing effectiveness qualities during their processing, physicomachanical properties and sturdiness (including when operated in countries with a tropical climate), specifications were developed and confirmed, and a waste-free technology to produce plastic perforated boxes was developed. The result of this work was an increase in the technical level of machine tools and their competitiveness on the world market which permitted a reduction in import sales and, additionally, the labor intensity of electrical installation work was decreased and working conditions were improved.

Work has now been introduced at more than 60 of the sector's machine tool building plants which has helped to theoretically free up 740 workers; the perforated boxes were awarded the State Emblem of Quality. During 1983-1985 the verified savings amounted to 2.8 million rubles.

A diploma and the second monetary prize of 500 rubles for the work "Development of VIRM-type Rotor Machines for the Uniform Cutting of Fibrous Materials" was given to S. V. Sherbakov, M. A. Demuskov, N. M. Klimashevich, A. G. Metelskiy, and Yu. I. Pushkarev (city of Gomel). This work is aimed at solving an important national economic problem connected with the processing of secondary natural and synthetic fibers. The machines which have been developed are not inferior to machines of the best foreign firms in their tactical and technical characteristics, and they are distinguished by design innovation (their main units are protected by five author's certificates), and by high economic effectiveness (60,000-80,000 rubles per machine) which, in the aggregate, has permitted a decline in the import of similar machines.

Another work, "Research and Development of Advanced Manufacturing Equipment and a Waste-Free Technology for Obtaining Metallic Polymer Composite Materials" also received second prize. Its authors Yu. S. Rybnikov (VNISI/All-Union Scientific Research Institute of Illuminating Engineering/) and A. I. Krashenninnikov (VZMI/All-Union Correspondence Institute of the Machine Building Industry/) suggested new advanced equipment--triboelectrical charging-spraying devices, automated spraying units and lines based on them for the production of metallic polymer materials. They have successfully solved the urgent problem of obtaining, with production intensification and a shortage of raw material, power and labor resources, materials combining the strength and hardness properties of metal with the high anti-corrosion resistance of plastic.

The equipment proposed by the authors eliminates manual labor, does not pollute the environment, is available for manufacture by any user enterprise (the cost of one complete equipment set does not exceed 50,000-60,000 rubles), allows a savings of ferrous rolled metal, electrical steel and other metals, increases labor productivity 5-12-fold, decreases labor intensity 5-10-fold, and increases the material utilization coefficient up to 98 percent. The savings from introducing equipment at only one enterprise, by lowering labor intensity and saving material, is no less than 200,000 rubles a year, and the yearly impact in the national economy with the introduction of one line amounts to more than one million rubles.

Three works received diplomas and monetary prizes of 300 rubles apiece. One of them--"Equipment for Manufacturing Bulk Articles Made of Thermoplast (Gears, Sprockets, etc.) Aimed at Reducing Import Sales of Casting Machines," reflects the research conducted by Ye. M. Pokrovskiy, O. A. Solodukha (of the NPO VNIIImetmash/All-Union Scientific Research, Planning and Design Institute of Metallurgical Machine Building/), Yu. A. Zubov, N. F. Bakeyev (NIFKhI/Physicochemical Scientific Research Institute imeni L. Ya. Karpov/), which has permitted obtaining optimum parameters in developing manufacturing processes for producing standard parts made of thermoplast by metal pressure-machining methods. The stamping equipment recommended by the authors for forming thermoplast in a hard state (FTS) permits a 2-2.7-fold increase in

the hardness of articles made of polyfiles, a 1.5-3.7-fold increase in strength, a 10-20 degree C increase in heat resistance; it is one-third less expensive than cast forms. The stamping equipment makes it possible to automate casting by using a waste-free manufacturing process, increases the quality of standard plastic articles, reduces power and materials intensity, and saves foreign exchange funds by decreasing import equipment purchases. The innovation in equipment design has been confirmed by an author's certificate and the economic impact from its introduction into production has amounted to more than 180,000 rubles.

The authors of another work which received third prize, I. Ye. Zakurenko, Ye. R. Svidzinskiy, R. I. Kovalev, A. G. Sergiyenko, and V. V. Chernikov from the Kharkov SKTB/Special Design and Technological Buro/ Mashpriborplastik developed a mechanized line for processing polymer material waste products with a productivity of 250 kilograms an hour. Possessing many significant advantages compared with the best equipment of foreign firms, the line carries out new effective processing methods: low-grade, large-dispersed grinding of dross; flotational separation of contaminants and foreign impurities; high-speed wash-off; agglomeration. Equipping enterprises with such equipment allows obtaining quality secondary polyethylene from waste products which can be used again in the production of articles of technical and everyday use. The yearly economic impact from operating a line at only one plant is 184,300 rubles.

In the third work "Creation and Introduction of an Equipment Complex for Processing Polymer Materials by the Rotational Casting Method," S. Ya. Kleyman, L. M. Abramov, U. S. Marsov, N. S. Loboda, B. A. Golender (NPO Technolog, city of Tashkent) have developed, manufactured and introduced industrial installations for the rotational casting of large-sized hollow articles made of polymer materials and highly productive industrial equipment for grinding granular thermoplasts by the high-speed cutting method. The innovation of the technical solutions was confirmed by nine author's certificates. In addition, the specialized waste-free production of polyethylene tanks of machines which chemically protect crops was organized with a yearly economic impact from their introduction of 600,000-800,000 rubles.

The following works were awarded diplomas of the TsP NTOMashprom:

--"A Line for the Manufacture of Large-Sized Polymer Billets and Articles" (authors: I. A. Shenbel, V. G. Fedorovich, S. M. Sazonkina, L. A. Nepran, N. A. Vorontsova from the NPO Polimerbyt, Moscow) permits carrying out a new manufacturing process to produce high quality thick-walled articles made of different polymer materials by the continuous method with an economic impact from its introduction of more than three million rubles;

--"Development of Advanced Manufacturing Equipment for Producing Plastic Seals for Gas Main Ball Cocks" (authors: B. S. Petrovskiy, I. T. Yarema, M. P. Yamko, P. V. Pshonyak, O. K. Shkolzinskiy from the Ternopol branch of the Lvov Polytechnic Institute). The reliability of the seals manufactured on the developed equipment is 5,200 hours which is 1,800 hours more than for a similar imported model. The economic impact from its introduction is more than 100,000 rubles; the savings obtained is more than 14,000 rubles of foreign exchange currency.

--"The Polimer-RTs-2 Unit for Measuring Visco-Elastic Properties of Thermo-setting Polymer Materials in the Hardening Process" (authors: A. D. Sokolov, V. A. Mironov, Ye. N. Mironov, Ye. N. Knyazev, I. R. Aleksandrovich from the Tula OKBA/Experimental Design Buro for Automation/ of the NPO Khimavtomatika and the Moscow NPO Plastik of the VO/all-union association/ Soyuzkhimplast. The unit is capable of replacing imported tools used for a similar purpose. The economic impact from its introduction is 10,000 rubles.

--"The Development of Equipment to Manufacture Corrosion-Resistant Rubber-Fluorolon Pump Diaphragms Instead of Importing Them" (authors: M. D. Parizenberg, Z. P. Roskosho, M. N. Bokshitskiy, V. M. Stepanov, V. I. Pimankin from the Moscow NPO Neftekhimavtomatika of USSR Minneftekhimprom/Ministry of the Petroleum Refining and Petrochemical Industry/. Organizing the production of rubber fluorolon diaphragms has permitted a decline in their importation. As a result, in 1985 alone an economic impact of 215,000 rubles was realized.

--"A Waste-Free Manufacturing Complex and Equipment for the Industrial Introduction of Domestic Brands of Polyurethane Instead of Import Purchases" (authors: N. G. Boydenko, G. V. Turlupov, B. Z. Zaslavskiy, V. D. Oreshnikov, A. Ya. Zanin from the Slavyansk branch of VNIImetmash). This work was introduced at enterprises of the metallurgical, aviation, construction, and a number of other sectors and has permitted the elimination of import sales of raw materials and special purpose equipment. The expected yearly economic impact in the national economy is more than 24 million rubles.

--"A Universal Automatic Line for the Production of Polyethylene Film Articles (Packets, Bags, Linen for Seed Beds, Tablecloths, etc.)." Equipment created by the creative brigade of innovative workers of the Kiev city branch of NTOMashprom, L. K. Lantsman, I. A. Parashin, A. M. Sergutin, and I. M. Matusevich permits obtaining film 150-1500 mm wide and 20-250 microns thick. The line provides the following: devices for obtaining equiwalld film along the entire perimeter or with a prescribed thickening in the required place stipulated by the article's design and for tightening crushed film in an auger which provides--fully waste-free production; a printing machine for applying dot areas which is close to color photography; an automatic machine for welding packets, sacks, bags, etc. controlled from an electronic block with a photocell capable of carrying out up to 40,000 joints a shift with a film thickness of 40 microns and of automatically packing the articles. The cost of the line is 180,000 rubles which is over three times less expensive than similar imported ones; the reimbursement period for the line is 0.4-0.5 year.

--"The Development of a Highly Productive Radiation Manufacturing Process for Producing Foiled Rolled Glass-Fiber Materials for Radio Engineering" was carried out by the creative brigade of the MGP/Moscow city branch/ of NTO-mashprom including Yu. P. Boychenko, V. T. Blokhin, V. N. Kestelman, and V. L. Sytyy. As a result, production was organized to manufacture rolled foil glass-fiber materials (dielectrics) which has permitted the creation of fundamentally new equipment for materials of domestic production and a decline in purchases of imported large-sized equipment. The economic impact from the introduction of this development has amounted to more than 700,000 rubles;

--"A Device for Winding Strengthening Tape on a Pipe" (authors: Ye. I. Yezer-skiy--VNIPKilegprodmontazh/All-Union Scientific Research and Planning-Design Institute of Light Production Installation Work/, R. A. Bychkov, T. A. Belova from VZMI). The device permits the simultaneous application on pipes of two layers of protective coating with its hardening at an increased temperature (PVKh/polyvinyl chloride/-plastisol composites are used as binders here);

--"The Development and Operation of an Automatic Installation for the Research and Control of Polymer Material Sturdiness" (authors: L. M. Pritykin, V. B. Marmazin, V. M. Vashchenko, O. G. Krayevoy, A. Ye. Brazilevskiy from Dnepro-petrovsk). The results obtained have been analyzed by a computer;

--"An Installation for Determining the Thermal Deformation and Deformation-Diffusion Properties of Polymer Film Materials" was carried out by members of the NTO VZMI A. M. Ternovyykh and S. S. Trushakov.

--"A Device for Determining the Diameter of a Cross Section of Sealing Rings Made of Polymer Materials" (authors: V. K. Pirankov and A. M. Rostovtsev from Moscow). The device allows a determination of the technical defects of parts manufactured in molds. Labor productivity, when measuring the rings in series production with the tool developed, increases 5-6-fold in comparison with optical instruments.

--"Designs of Hot-Channel, Runnerless, and Waste-Free Casting Molds" was carried out by a member of the section of TsP NTOMashprom N. B. Vidgof. Using the molds developed provides a 5-12-fold increase in labor productivity in comparison with traditional ones and permits the elimination of import sales.

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WORKABILITY OF MATERIALS ON NUMERICALLY CONTROLLED MACHINES

Moscow MEKHAIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 4, Apr 86
pp 14-15

[Article by Candidate of Technical Sciences A.V. Kibalchenko, and Engineers
S.P. Babak, G.A. Zhigarev and A.N. Shubin]

[Abstract] Mathematical experimental methods are known to determine the workability of materials on numerically controlled machine tools. Experiments have been performed at Moscow's higher technical school imeni N.E. Bauman on optimization of cutting speed for various types of difficult materials, indicating that the optimal cutting speed can be defined by a study of the acoustical emission of the cutting process. The acoustical emission method can also be used to select optimal feed and cutting depth. An experimental study was performed to confirm the possibility of using the distribution of acoustical emission amplitudes to estimate the workability of new materials, involving machining the ends of disks of materials on a model 16K20 lathe. The results indicated that amplitude analysis of acoustical emissions can be used to determine the relative workability of materials. Figures 3.

UDC 621.757.06

SELECTION OF EQUIPMENT FOR AUTOMATING ASSEMBLY OF PRODUCTS IN SERIES AND MASSIVE PRODUCTION FACILITIES

Moscow MEKHAIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 4, Apr 86
pp 17-19

[Article by Doctor of Technical Sciences A.A. Gusev]

[Abstract] A major reason that expensive "smart" industrial robots must be used rather than simple manipulators in many assembly operations is the complex and variable trajectory of movement through which parts must be carried. If the complex trajectory can be converted to a simple and constant trajectory, a simple manipulator can replace the much more expensive industrial robot. Conditions are discussed under which this transition is possible, allowing complex industrial robots to be replaced with simple cam-controlled manipulators. A key factor is the need for transport devices such as conveyor belts to place products for assembly in exactly the same location each time to allow simple manipulators to grasp them properly for assembly. Figures 4.

AUTOMATION OF MONITORING OF VIBRATION TREATMENT PROCESS WITH TYPE SKPV-6
EQUIPMENT

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 4, Apr 86
pp 24-25

[Article by Candidate of Technical Sciences B.N. Kartyshev and Engineer V.I.
Omelchenko]

[Abstract] The SKPV-6 equipment rack has been developed for automation of control of vibration working of products. The equipment allows measurement and recording of the amplitudes of oscillations of the moving parts of vibrating equipment and the time of treatment of parts, as well as continuous monitoring of amplitudes with independent setting of the width of the discrimination window for different channels and limit control of the minimum oscillating frequency. The equipment can also be used to disconnect vibration waves under emergency conditions, while simultaneously stopping the movement of the charts in strip-chart recorders. A photograph and block diagram of the modules of the device are presented. Servicing of the equipment is minimal: switching on at the beginning of a shift; switching off and removal of the strip charts at the end of the shift; and monthly refilling of strip chart pens with ink. The economic effect of use of the device is at least 1,000 rubles per year for a single vibration installation. Figures 2.

6508/6091

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658.52.011.56.012.3.004.14

USE OF INCREASED AUTOMATION IN MACHINE PROCESSING-INDUSTRIES DISCUSSED

Moscow MASHINISTROTTEL in Russian No 8, Aug 86 pp 10-12

[Article by Candidate of Technical Sciences V. I. Zagurskiy: "Important Questions in Robotizing Machine Processing Industries"]

[Text] The automation of production processes while reducing the replaceability periods of output items--this is the most characteristic trait of modern machine building. Successes in automating large series and mass production, achieved during the preceding half century, would have been impossible if the costs of creating aggregate and special machine tools, automated lines or other advanced equipment were not justified through the repeated growth in the output levels of products of the same type. At the same time the proportion of machine building industries with a sufficient output quantity of products of the same kind has always been limited, and it has even been decreasing recently. The tasks of production automation remain on the agenda and its role is growing. By using machine tools with NC [numerical control], multipurpose machine tools, readjusted automatic lines, and also industrial robots for loading and unloading machined parts, automation is penetrating all the more the vast area of multiple products list series production. Group sectors and lines made up of machines with NC which are serviced by industrial robots, a specialized transportation-warehouse and packaging industry, and which have been designed for the automated manufacture of parts with batches of the most diverse, including small, sizes are being introduced.

Until recently automation was considered a natural development of mechanization, though at a qualitatively new level. Automation, and even more so, complex automation in reality has even meant a loss by industry of the flexibility which was inherent to the earlier stages of machine building development.

The successes of microelectronics, particularly the creation of microprocessors, have led to a fundamental change in the very nature of automating machine-processing production. The tendency leading to the creation of flexible and quickly-readjustable automated industries of a different level--this is the direct consequence of using electronic control devices. Objects controlled by numerical programming--machine tools with NC and others are undergoing appropriate changes, and efficiently operating multipurpose machine tools (machining centers) and industrial robots are appearing. However, the path to the production systems of the future lies through the integration of such components as manufacturing equipment with NC, industrial robots, flexible transportation systems, and automated multistage warehouses.

The entry of blanks from storage areas to machining areas, and the transfer of machined parts between them, during which process the necessary operations (technological transfers) are conducted in the prescribed sequence, respond to the transmission of control information into the production system. Electronic equipment to control the production of items of a sufficiently small series must provide the operation of a GPS/flexible production system/ according to the flow principle (analogous to traditional flow mass production but with the possibility for free choice and a change in course).

Flexibility ought to be considered here primarily both as the ability of a highly-automated plant to switch sufficiently often, quickly and economically to the manufacture of new items within the technological possibilities of the system and as the ability of the latter to function by adapting to changes in the originally programmed work schedule caused by organizational and other reasons. In addition, there must be the possibility to regroup the sections and units of the GPS for the purpose of switching them to the output of a new final product when a radical modernization of production is routinely taking place without large capital outlays and time periods for its achievement. The introduction of industrial robots has been economically justified in automated flow production as well as in series production, in combination with the programmed control of technical equipment and especially as part of flexible and readjusted automated manufacturing systems.

Each robotized complex or sector can be a one- or multi-product production unit machining a specific number of part sizes. It is foolish to attach a first generation robot to an ordinary machine tool with manual control--it is necessary to modernize such a machine tool into a semi-automatic machine.

For the wide use of industrial robots in flexible automated manufacturing systems, it is necessary to reorganize production toward a clearer, frequently intersectorial specialization that can be done by enlarging part batches and group machining them. Thus, the solution of technical problems rests here on the solving of organizational and economic problems. According to common opinion, one of the major prerequisites in improving production management is arranging a parts list of manufactured articles and introducing specialization and cooperation into the production of standard (standardized) parts and units. It is also known that the standardization of parts and assembly units, which provide the constructional and technological homogeneity of production and its elements (seating diameters, types and sizes of threads, etc.), eliminates duplication, reduces the variety of sizes, and lowers expenditures of funds and time on the technical preparation of production. The technical level and quality of production simultaneously increase. Standardization on the intersectorial level is especially effective.

At enterprises with series production, managed according to the principle of closed-subject specialization, which have a full collection of main and auxiliary shops also equipped with universal equipment, labor productivity is 4-fold lower and the production cost is 2-2.5-fold higher than at large automated machine building enterprises. However, the point is not in the enterprise sizes themselves; productivity is determined mainly by the level of automation and the degree of uniformity of production output or the technology used, and the advanced state of the latter. All of this is possible in production concentration, though it is not concentration altogether but something which can be called specialized production concentration.

A part, manufactured at a specialized enterprise, is several times less expensive than one produced at an enterprise which has available an entire set of manufacturing process stages necessary to produce a finished machine. Flexible automated plants, with their sufficiently broad spread, are undoubtedly a real basis for the detailed and technological specialization of machine building plants. Such enterprises, of course, cannot function without well-defined cooperation. The gradual switch from objective to detailed, and in preparation plants--to technological (operational) cooperation, will turn machine building to a significant degree into an integrated complex of narrowly specialized plants. The Basic Directions for the Economic and Social Development of the USSR in the Years 1986-1990 and to the Year 2000 provide for such production cooperation in which machine assembly enterprises are combined with specialized plants. The numerical control of machine tools (moving their actuating devices, changing the tool, etc.) yields a number of advantages. However, it is still not enough in itself to machine parts without the direct participation of a person--the operator. Automating the loading of manufacturing equipment and making non-labor intensive (in the final analysis, automated) readjustment possible when switching to a new parts batch, etc., are necessary for "personless" (fully programmed) production. The problem is complicated by the fact that when switching to machining a part of another size, it is not enough to change the control program and begin feeding other blanks which were machined, if required, by other tools of the complex.

In addition to a technological readjustment of the machine tools, a geometric readjustment is also still necessary, accompanied in addition by a precise dimensional resetting. If the static adjustment of the tool for the prescribed size essentially provides for the movement of the actuating devices supporting the tool, according to a set program embedded in a computer, then it is managed during automatic readjustment in a majority of cases without adaptive control systems. Such a control system is supplied with a correction block which receives and reprocesses information coming from monitors and measuring devices into controlling signals. For a self-adjustment, a test pass is first carried out or a test part is machined and then, by measuring the appropriate size, the information obtained is used to correct the position of the tool through a device with numerical control.

The automation of a machine tool's technological adjustment requires the receipt and use of information on the condition of the machine tool in action. Cutting torque sensors, vibration sensors, etc., which are part of the adaptive system, are used here. Those elements of the cutting mode which are control parameters in the given adaptive system are established or made more precise based on their signals and including the criteria previously introduced into the program. The changeable geometry of the tool which is of definite interest for a number of machining methods can also belong to the latter.

The second of the machine tool adaptive system functions examined is essentially related to the problem of routine self-readjustment but, like the first one, it is caused by the inadequacy of prior information which is originated during the formation of the numerical control program of the machine tool. When machining a part (or batch of parts) the condition of the SPID /machine tool-guiding device-cutting tool-work piece/ system changes continuously. In this case, routine self-readjustment permits the optimization of accuracy and machining productivity which is preliminarily only nominally prescribed, and the manufacturing equipment maintenance functions become simpler and can be turned over to a robot.

In a "peopleless" fully-programmed machine tool system operation, its reliability assumes paramount importance. The solution to this problem is connected to the creation of new modern-in-operation machine tool mechanisms, and to the effective use in them of electronics, overload and breakdown protection systems, and diagnostic systems and devices. The numerous directions in improving automated plant equipment are considered basic at the present time.

Systems and devices to grind shavings and remove them from the machining area, to control the arrangement of the machined part in fittings, to control the condition of the tool (physical and dimensional wear, absence of fractures, etc.), to control the load on the tool and basic units of the machine tool are necessary for the reliable protection of the machine tool during operation.

Machine tool operation accuracy diagnostics are carried out for such parameters as the temperature in the moving joints, oil temperature, dynamic errors in the servo gears, etc.

Through the achievements of electronics, the informational readjustment of the GPS machining can be carried out quickly enough (the necessary data on the blank before starting the next batch enter the computer which, in turn, issues the appropriate programs to the machine tool's microprocessors). The work on doing the technological readjustment does not go so smoothly: the requirement to increase the level of automation and provide real production flexibility is connected with future qualitative changes in machine tool attachment designs and with an improvement in the tool, an increase in its efficiency, and a rise in the proportion of the utilized combination and multi-tooth tool. The inclusion in the unit of doubler tools and the introduction of automating resetting and readjustment for the machining size by using quick-changing (including automatically changed) tool blocks, including spindle-type, multi-tool heads must be viewed with inevitability. Automatic tool changing must be safe to accomplish, take up a minimum of time, and be carried out of necessity by a robot.

The replacement of clamping devices and their readjustment performed by special mechanisms must still be part of the work program of machine tool models. Appropriate monitors must control the accuracy of placing each billet with a clamp. Industrial robots must be used not only as machined part handlers but also for manipulating (by a program) the changeable elements of clamping chucks and other devices.

When developing the RTK/robotized technical system and GPS, a whole set of problems dealing with their effective operation has to be solved: determining the area of use and optimizing the make-up of the basic manufacturing equipment of the GPS so that it is used to the highest degree; providing for production management at a level which will ensure the normal functioning of a "peopleless" production system; using the mechanical and other sections of the system which have increased reliability for which a knowledge of the facts and causes of operated GPS equipment failures is necessary. Experience shows that although a significant part of numerically-controlled machine tool failures is connected with the unsatisfactory operation of electrical devices

and NC devices, mechanical units require the greatest expenditure of time to restore their efficiency. The reliability of many models of industrial robots is inadequate at a time when it must not be lower than the reliability of basic manufacturing equipment functions. Efforts which have been applied to increasing the reliability of all units making up the RTK and GPS are being justified through the possibility of effectively operating them with the minimum participation of maintenance personnel.

A machine tool with NC is the central unit at the present time in automating the machining of parts in batches. Direct numerical control of a machine tool turns out to be the most flexible and versatile way suitable for machining cycle automation. This is the first level of flexible automation which is characterized by the transfer by the person to the machine tool of the functions to control the auxiliary movements of the actuating devices.

Loading functions are still automated at the second level and, because of this, the possibilities for multi-machine tool (multi-unit) maintenance are growing sharply. Industrial robots are distinguished by the greatest universality among the similar means for servicing manufacturing equipment.

The third level of automation relates to those functions earlier carried out by the machine tool operator, such as: controlling the dimensional stability and physical efficiency of the tool by providing for its timely replacement; controlling the dimensions and, in a number of cases, also some other parameters of machining quality; controlling and stabilizing the manufacturing process (correction, self-readjustment); controlling the operation and condition of the machine tool units; removing shavings.

The automation of the enumerated functions requires equipping the machine tool with sensors, measuring devices, adaptive control systems, microprocessors, and function transmission channels to control a group of computer equipment.

The fourth level of machining automation is linked with solving the problems of readjusting equipment without the direct participation of a person. In connection with this, manufacturing equipment and the systems to readjust it, technological accessories and the tool, means to control parts, their loading, basing methods, etc. must be improved.

When robotized complexes and sectors are organized by the efforts of the enterprises themselves, it must be kept in mind that the machine tools manufactured with NC, and especially the usual kind of semiautomatic machines (for example, thread-generating ones), as a rule are not expected to be maintained by industrial robots and the problems in coordinating the serviced equipment and industrial robot control systems must be solved when robotizing; the automatic conduct of such operations as clamping parts in a chuck (for flanges), gripping the end of a part by a carrier (for shafts), holding and clamping on a table (for parts which do not rotate during machining); the creation of a wide range of clamping chucks which reduce the time for readjusting machine tools; the automation of moving protective panels; blocking, signalization, etc.

When laying out an RTK by using existing equipment and selecting a manufactured type of PR [industrial robot], work on the modernization, completion, joining, and working out of an interaction removes the basic manufacturing equipment from the production process for a long time and requires considerable expenditures. Hence, there is general interest in acquiring a series-produced RTK (for example, the RTK for lathe work manufactured by the Moscow Krasnyy Proletariy Tool Building Plant imeni A. I. Yefremov). Their parts list is gradually increasing but still does not include all required variations. In this connection, it is evidently advisable in the machine building sectors to have lead organizations assisting in the planned robotization of production.

When servicing metal-cutting machine tools with industrial robots, their incorporation into the machine tool is happening ever more often. Robotized lathe, gear-machining or other models of this type are very compact but they rule out multi-machine maintenance with a PR. Therefore robots, as a rule equipped with a double clamping device built into the machine tool, are used in those cases where the machining time does not exceed 3-5 minutes, and the weight of the part is not more than 10 kilograms (more rarely, 20 kilograms).

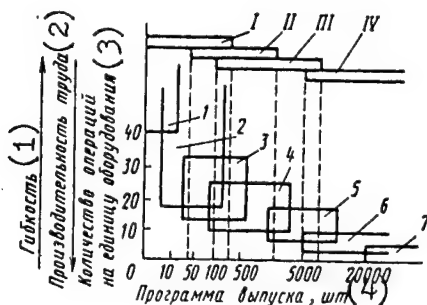
Gantry-type robots are often used in automated lines. A linear arrangement using gantry PR's has an advantage when maintaining a group of machine tools or one machine tool, machining small parts along with heavy parts (up to 160 kilograms). Gantry robots are often specialized and are an attachment to the machine tool in this case.

In a parallel or circular arrangement RTK, one machine tool or a group of machine tools are maintained by ground robots, most often universal ones. These PR's can be rotated around a vertical axis and can maintain machine tools with horizontal and vertical spindle axes. In comparison with gantry robots, they are less metal-intensive and equipment planning can be freer here.

At machine building enterprises with large series production, industrial robots are looked upon when deciding automation questions as only another effective way to free people from direct participation in physically hard, monotonous, unattractive, and also at times health-harming work in those cases where there is no success in eliminating this work with a radical change in the manufacturing process. However, simple and inexpensive automatic manipulators are then primarily used. Robotization requires large costs but it is conditioned primarily by the impossibility of using simpler solutions when a sufficiently ideal and effective technology does not relieve production from manual labor.

An example of the very successful use of PR's in machine assembly work is watch production where, through robotization, the proportion of manual labor can be reduced 2-3-fold and productivity has been sharply increased. Thus, in the shops of the Pervyy Watch Plant imeni S. M. Kirov about 800 small size PR's have now been installed and are in operation and plans call for raising their number to 2,600 by 1988 which should raise labor productivity by almost 40 percent.

Diagram 1



Key:

1. Flexibility
2. Labor productivity
3. Number of operations per equipment unit
4. Output program, in pieces

In motor vehicle building, it is possible to concentrate and robotize to a significant degree at a small number of enterprises (VAZ/Volga Motor Vehicle Plant, KamAZ/Kama Motor Vehicle Plant, AZLK/Motor Vehicle Plant imeni Leninskiy Komsomol, and others), converting them into multi-product readjustable plants, thereby laying the foundation for a quick and painless shift to the output of new units and articles.

The dependence of production flexibility and labor productivity on the number of operations there must be per unit of equipment and of the programs for manufacturing parts with specific equipment can be seen in the diagram where I is tool and test production; II is the production of specialized motor vehicles and special bearings; III is the production of buses and automatic loaders; IV is the production of motor vehicles, bearings, and motor vehicle electrical instruments; 1 is general purpose machine tools with manual control; 2 is machine tools with NC; 3 is a GPM/flexible manufacturing module; 4 is a GAU/flexible automated section; 5 is sectors having readjusted aggregate machine tools; 6 is readjusted robotized multi-product lines; 7 is automated lines with a traditional transport link; aggregate and special machine tools, automatic and semiautomatic machines with mechanical control of the work cycle.

An effective solution to the problems of robotization is impossible without a carefully thought-out program for the technical re-equipping of production. Project preparation must unfailingly precede the introduction of RTK's and robotized lines. The situation at the present time is that the introduction of one PR frees one machine tool operator on a shift with 2-3 maintenance workers. Thus, at one enterprise an automated line replaced one machine tool and, thanks to this, the machine tool intensity of machining decreased. However, maintenance labor intensity grew so much that eight operators and adjusters are now needed here in place of the previous machine tool operator and the flexibility of the new line is spread out for parts of only two designations.

The introduction of a PR must be dictated not simply by the possibilities of technically accomplishing a project, but by its technical and economic foundations, a calculation of its production prospects, and the solution of organizational questions ensuring the fulfillment of all stages of robotization without deviating from solving the problems connected with it. A number of

other conditions are also necessary for the effective conduct of robotization. For example, it is more advantageous to immediately use several PR's in one manufacturing chain because this opens the way to the further shift of a sector to a personless mode.

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ROBOTICS

AUTOMATED CONVEYORS, AUTOMATION ATTITUDES DISCUSSED

Moscow SOVETSKAYA ROSSIYA in Russian 16 Sep 86 p 1

[Article by Aleksandr Shchegolev, correspondent for the Krasnoyarsk Kray and Tuvinsk ASSR: "Our Correspondent's View: The Robot on the Conveyor"]

[Text] We found the abandoned section at the very end of the factory building, beyond the stockpile of raw materials and final products. There was a thick layer of dust on the press and manipulators. Apparently even the shop cleanup personnel avoided what had now become a collection of unnecessary steel sculptures.

"Here it is, our first complex. It's hard to say when we'll start it up again." You could hear the sadness in the voice of Yu. N. Matashov, the shop manager. "Everything added up fine at first, but then the robots 'didn't work out' and we were at a loss. We needed qualified electronics technicians. Where could they be found? We train ordinary stamp operators in one month, but even six months isn't enough for electronics technicians."

I look at the dead robotized complex and remember how it began to "bake" frying pans about five years ago at this consumer product shop in the Krasnoyarsk Metallurgical Plant. It was intended as a broad response to this social need. By this time the robots should have replaced 60% of the shop's workers. It didn't happen. "Smart" automated equipment never became a part of the everyday scene at this factory. These devices broke down due to air pressure drops; new production had been connected to the compressor room, there were voltage variations in the grid and even ordinary failures took their toll. The plan was not fulfilled and workers became nervous. Wages fell sharply. Finally the manipulators were stopped.

Today the shop manager reflects: "Robots for the sake of robots? Is that really what we need? Look, we assemble a multi-item press with productivity that is an order of magnitude above that of previous equipment. We'd like an automated line built around that press and robots. Of course, no one in the country is designing these types of lines for Group B facilities. Are we supposed to order them from abroad? We have to do some serious thought."

Like chicken pox in children, robot "fads" were breaking out in many enterprises. I recently spoke with Professor A. P. Dambrauskas, doctor of

technical sciences, of the Krasnoyarsk Polytechnical Institute. In conjunction with leading factories in the kray center, he founded a flexible automated manufacturing training facility at the recently opened Robotics Department. He sees how deficient equipment stays in enterprise warehouses for years. In many cases factories ordered this equipment without having any idea of what they needed.

Thinking is more realistic now. "In each specific case there must be prior consideration of whether a robot would be advantageous in one operation or another. It is dangerous and wasteful to turn their introduction into a fad and to try to bring in large numbers of them." These are the words of N. G. Davidov, technical department manager at the Divnogorsk Low-Voltage Apparatus Plant. "I believe our greatest need is not for simple manipulators but for some kind of third-generation robots with very low 'intelligence.' They are irreplaceable for applications with frequent process changes and low-volume output."

At this time there are a few very simple robotized modules in operation at the Divnogorsk plant. They were developed by engineer A. T. Ryzhenkov's group (he is a true enthusiast). But there is a paradox here. Not every operator is eager to give up his monotonous job for the task of controlling a manipulator. The line of thought is: I fulfill the standards on my machine tool and that provides me with a salary. In a robotized complex I'll produce more, my responsibility will be greater and I'll need more knowledge. What about my salary. It won't change. Is it all worth it?

"We have to reexamine the way standards are set," Ryzhenkov says. "If we are more courageous in introducing provisional coefficients for mastering new products and equipment, things will work out."

This has been attempted at the enterprise and technicians still remain skeptical about new equipment. This is not an isolated case. In the words of I. P. Drozdov, deputy director of a truck trailer factory's mechanization and automation department, "There are two reasons for distrust of automated equipment. The first involves their reliability and the second is that there simply aren't very many of them. Actually there are no more than one or two here."

In fact there are a great deal more of them at the Krasnoyarsk Combine Plant. During the five-year plan the combine builders are to introduce another three flexible manufacturing systems and quintuple the number of NC machine tools. How are things going here? I came to the factory when all three flexible manufacturing modules for shaft grinding in the transmission shop were idle.

"What would we be doing if they had taken out the old machine tools?" asked A. Ye. Kuleshov, the shop's deputy director for production. "The plant would shut down! These modules are built by the Kharkov Production Association imeni Kosior. They answer our messages by saying: 'we can't send any managers, we don't have enough people.' So what are we supposed to do here?"

The office of the NC machine tool and robot operations manager at the harvesting combine production association resembles a headquarters set up to

deal with a natural disaster. The rings of long-distance telephone calls fill the air. Siberian "messengers" from Kuybyshev, Kharkov and other cities around the country report the results of meetings with factories producing errant robots. Usually the answers are not comforting. At times like this it is easy to see why shop managers are attached to the old equipment and "routinely" oppose new equipment.

To be sure, much reorganization is required at the work stations. Robot operation is primarily discontinued in areas where process and manufacturing discipline have not developed. You can't explain to a robot why there were no blanks at the beginning of the month but at the end of the month everybody has to frantically get the work out. You can't assign dozens of assistants to a robot in order to help it catch up. At the same time, the claims of production personnel are not exaggerated.

"Robots are not reliable enough," says S. P. Moiseyev, the harvesting combine production association's deputy chief engineer. "The manufacturers have to set up 100% monitoring for all components and place the highest possible requirements on their products."

The quality problem even reaches into bureaucratic organizational boundaries. Here is the system as it stands: mainframe computers are produced by the Ministry of the Radio Industry, small computers by the Ministry of Instrument Making, Automation Equipment and Control Systems, microprocessors by the Ministry of the Electronics Industry, NC systems by the Ministry of Instrument Making, Automation Equipment and Control Systems and electronic automation and drive systems by the ministries of the Electrical Equipment Industry and the Machine Tool and Tool Building Industry. All of these organizations are "confined" to their own areas and handle installation, warranty repairs and equipment maintenance. Instead of operating in an integrated manner they work separately and at times even duplicate efforts. As expected, each organization has its own administrative organization, equipment, buildings, fixtures and transportation. Bureaucratic interests also force each of these organizations to use any means to protect its ministry's "empire." The end result is that the manufacturing plants do not receive any feedback on the quality of their products and they blissfully continue to promote waste.

Just think of how many difficulties arise from the fact that there is only one Ministry of the Machine Tool and Tool Building Industry Main Administration for Machine Tool Repair and Calibration enterprise in the huge area between the Ural Mountains and the Far East. The 24 other robotics maintenance centers are in the country's European Region. Moreover, in Krasnoyarsk alone nearly 700 robotized complexes and manipulators are operational. This number will double by the end of the 12th Five-Year Plan. Combine builders are preparing an order list of flexible automated manufacturing modules and units built by the Ministry of the Machine Tool and Tool Building Industry. In a manner of speaking this is a program for the entire 12th Five-Year Plan. "You look at it and marvel," acknowledges S. P. Moiseyev. "Judging by the list not a single flexible automated manufacturing facility is left out! There are automated conveyor and storage systems, electric robot trolleys, tool calibration and parameter measuring devices and even other things that simply don't exist. Where can we order them?"

The numbers show that the departmental installation and maintenance organizations servicing machine building interests need restructuring and that it is time they were combined into an interdepartmental service system. At the Council of Ministers' request the USSR Gosplan examined the Krasnoyarsk party kraykom's proposals and concluded that implementation of the planned measures would allow further improvement in the repair and maintenance of automated machinery and computers, the release of more than 850 thousand workers involved in maintenance item manufacturing and the saving of up to three billion rubles per year in labor and materials expenditures. Only one conclusion can be drawn: Start the reorganization!

12746

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ROBOTICS

TRAINING OF AUTOMATION SERVICE PERSONNEL DISCUSSED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 25 Oct 86 p 1

[Article, bylined (TASS), Moscow: "New Equipment In Skilled Hands"]

[Text] The changeover of the economy to intensification tracks is being actively accompanied by enterprise retooling. This year alone, more than 8,000 industrial robots have been introduced. Skilled people are needed to service them. The CPSU Central Committee Politburo has discussed the problem of training and retraining personnel to master the new equipment and technology. It was noted that the work must be set up so that the training of skilled workers outstrips the creation of new production facilities, as well as the renovation and retooling of existing enterprises. In particular, personnel retraining is to be done in special departments attached to institutions of higher learning.

"Such departments have the flexibility and the ability to respond quickly to the needs of science and industry, to train personnel for them efficiently," says I. Ivanov, deputy chief of the USSR Ministry of Higher and Secondary Special Education's financial planning administration. "They are precisely the ones who should be training the first specialists in the fields of laser, plasma and membrane technologies, computers, flexible manufacturing systems, robot engineering, and rotary conveyor lines. Mastery of such technologies and modern equipment will put both individual types of production and entire branches at a qualitatively new level. As a result, labor productivity will increase many-fold, and the labor itself will become more creative and more attractive.

Emissaries from enterprises, scientific research institutions, ministries and departments are studying at these special departments, which are currently being operated at more than 60 VUZ's. They all have higher educations and are working in the fields for which it has been decided to retrain them. If on leave of absence from their jobs, the training is nine months; if while on the job -- up to a year and a half. The students are paid a stipend equivalent to their salaries.

These departments were first opened in the country's 12 largest VUZ's. The students were trained in seven promising fields, in particular, economic forecasting, robot and manipulator design, and magnetic memory physics and equipment. The lectures were given by prominent scientists and specialists from enterprises,

planning and design organizations. This past five-year plan, these special departments retrained 12,000 specialists from different fields.

In order that production receive specialists capable of operating modern equipment, the vocational-technical schools are training people to service machining centers, flexible manufacturing systems and other equipment which accelerates scientific-technical progress, says A. P. Dumachev, chairman of the USSR State Committee for Vocational-Technical Education. All the schools in his system have introduced a course on "Principles of Computers and Data Processing," and the schedule of classes for the current academic year offers "Computer-Based Production Automation." The vocational-technical education system is being given a large role in the measures planned to substantially improve the planning and organization of personnel training and retraining in new equipment and technology, in skill improvement and development training methods. We intend to make greater use of the experience in Leningrad, Perm and other regions in creating new branch and interbranch vocational-technical schools for the priority areas of scientific-technical progress. Extensive development of a network of interbranch training centers at enterprises developing the new equipment is anticipated.

In order to eliminate overproduction of personnel for some occupations and shortages in others, to balance worker training closely with the requirements of branches of the national economy, we plan to change over to a contract system of worker training and retraining in the vocational-technical schools, including training on a cost-accounting basis.

This will permit increased enterprise responsibility for creating the material and training base of the vocational-technical schools and significant improvement in work planning. The primary task is to ensure the outstripping training of worker personnel to service the new equipment.

11052

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ROBOTICS

DOMESTIC ANSWERS TO SUPER COMPUTERS, ROBOTS SOUGHT

Moscow STROITELNAYA GAZETA in Russian 5 Nov 86 p 3

[Article by Ye. Kryshelnitskiy (Moscow) under the heading "In the Institutes and Laboratories": "Sharp-Eyed Robot"]

[Text] Specialists at the Systems Research VNII [All-Union Scientific Research Institute] have developed a new principle for guiding new-generation robotized systems.

Imagine this: high on a construction site wall, right up under the roof, where people need both skill and steady nerves, a robot welder is working. But then the robot needs to be told to do something else. What to do? Changing the program is something that must be done carefully, and not way up in the air. Production would have to be stopped. Couldn't a dumb machine be made into a worker capable of acting as circumstances dictate?

Specialists think that to do this, robots will have to be equipped with numerous assistants, or accessories, to adapt the technology to them, to take production possibilities into account, to provide everything they need. This means we need not just robots, but robotized complexes able to adjust themselves quickly to new tasks. That is what the developers of today's robot equipment are doing.

"The time has come for a new generation of robots, adaptive robots which can change their own programs as they work, as circumstances dictate," says Candidate of Technical Sciences V. Rakhmankulov, head of a laboratory of the theory and principles of building flexible production units. "In fact, it is impossible to calculate ahead of time the mechanism's movement coordinates for every situation that might arise, and it is time-consuming to be constantly changing the program. Much better if the robot itself solves that problem by evaluating the situation and transmitting the information to its electronic brain, which will make a decision that conforms to a flexible program.

Programmers have begun working differently as well. They no longer need to debug a program for a specific piece of equipment. The robot uses a television camera to transmit images of the situation at the workplace to a display. This can be done without the participation of the robot, which continues to do its job. The operator then writes a program using the information from the screen.

The display helps him see how each instruction will be executed. Moreover, situations which cannot be easily reproduced under ordinary circumstances can be simulated on the screen.

This new operating principle is essentially a figurative dialog between a person and the machine being controlled. Implementing the principle is not easy, however, due to the limitations of existing computers. Comparatively small microcomputers are ordinarily used in robots. The larger, multipurpose computers are ill-suited to solving robot engineering tasks. Institute specialists have been able to create special processor modules which enable an ordinary Elektronika-60 desktop computer to process images at 50 frames a second. This is enough to allow the robot to respond promptly to changing circumstances or, as the programmers say, to operate in a real time frame.

"Overseas, people rely on superpowerful microcomputers to resolve such tasks," V. Rakhmankulov says, "but we are seeking our own approaches to the problem, because always playing catch-up with the leaders is a losing game in science. And really, why increase the power of the computer when you aren't using all the power you already have? We have therefore consciously rejected that path and have succeeded in solving the problem using existing units with new programming and hardware. The results are just as good as those achieved abroad, but the cost is much lower.

The country plans to introduce robots extensively this five-year plan, including in automotive industry, machine-tool manufacturing and construction. The robots will not operate independently, but as integral parts of machine tools and technological lines. This is quite a bit more complicated than creating skillful automata which work "by themselves." Still, there was no other way without missing the very point of robotization. As distinct from automatic machines, robots can adjust flexibly to perform other jobs. With their "eyes," they are no longer helpless if the task changes.

Using robots not only relieves people of unchanging, routine labor, but also permits shortening the production cycle. People at the institute think acceleration is the primary result of robotization. High-quality, competitive products and on-time deliveries will all be made possible by intelligent machines.

11052
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ROBOTICS

FORGING SHOP ROBOTS

Moscow NAUKA V SSSR in Russian No 3, Jan-Feb 86 pp 80-82

[Article by V.V. Karzhan, Candidate of Technical Sciences, Fellow ENIKSMASH Scientific-Production Association, Voronezh]

[Abstract] A discussion is presented of the utilization of robot manipulators in forging and pressing shops. The first 2-armed automatic robot for forging and pressing production, the PRTS, was produced in 1974. In 1983, a 3-armed PRTS was shown in Paris at EMO-5. This machine is capable of servicing 2-high speed stamping machines. An automated system for stamping of gas-flame apparatus parts has now been installed at "Avtogenmash" Plant in Kirovokan. The system consists of a stamping press with two slides, each with a force of 1,000 KN and an automatic loading and unloading system. ENIKMASH has also developed a forging system which includes a press, manipulator and electric car for forging of shaft, cube and ring parts replacing a hammer serviced by a team of 6 men. Future projects will include robots which can adapt to the situation at hand.

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IMPROVED REPAIR OF PROGRAMMED CONTROL MACHINE TOOLS AND ROBOTS

Moscow MASHINOSTROITEL in Russian No 4, Apr 86 pp 27-28

[Article by Engineers N.N. Ivanova and I.N. Vorobyev]

[Abstract] The authors' (unnamed) enterprise has created a special office for maintenance and repair of program-controlled machine tools and robots, which require more frequent preventive maintenance than less complex machines. Planned preventive maintenance is performed by combined repair and maintenance teams where the equipment is installed, while overhauls and major repairs are usually performed in the plant repair shops. Modular methods are used, swapping entire sections of machines to be repaired in the shop. The plant has calculated the number of workers required for preventive maintenance and repair of such machines by specialty. Improving the organization of the maintenance and repair service for program-controlled machine tools and robots allows reduction in machine downtime, reduction in labor consumption of maintenance and improved utilization factor of machines, achieving a calculated annual savings of 60,700 rubles.

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CSO: 1823/315

SPECIAL CLAMP DEVICE FOR INDUSTRIAL ROBOTS

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 7, Jul 86
pp 12-13

[Article by Doctor of Technical Sciences R.A. Aliev and Engineer Z.I.
Farkhadov]

[Abstract] Available clamping devices for clamping and holding of flat parts are insufficiently reliable for situations in which an industrial robot receives a packet of two identical aluminum sheets, one of which carries a figure, and transports them to a rolling mill. The Sumgait Technical School has developed a special clamping device for feeding packets into rolling mills. The device consists of identical clamps displaced over the plane of the sheet and connected by a differential lever with a drive shaft. Each clamp has holding pads parallel to the clamping axis forming an articulated parallelogram with the body. The clamping device has the properties necessary for reliable functioning of an industrial robot. This article determines the clamping force of the clamping device necessary to hold the packet as the robot functions in a specific production situation. The calculations presented were utilized in the design of clamping devices which have been tested at the Sumgait aluminum plant in the production of aluminum heat exchangers. Figures 2.

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THE CONCEPT OF THE 'MODULE' IN TECHNOLOGY

Moscow STANDARTY I KACHESTVO in Russian No 5, May 86 pp 32-33

[Article by A.M. Lyubavin, All-Union Scientific Research Institute of Machine Building]

[Abstract] The term "module" is interpreted quite variously in Soviet machine building technical literature. The discussion of this concept presented in this article is somewhat hampered by the fact that the Russian word for module also means "modulus," so that the work may refer to a portion of a larger aggregate or a physical quantity. It is suggested that a module is a structural element or unit of a modular system, which in turn is a set of functionally related structures intended to perform a task regulated by a single set of documentation. A structural module should be functionally, structurally and technologically complete within itself. Examples of structural modules are presented. References: 15 Russian.

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USE OF ELECTRIC WORKING IN TOOL MANUFACTURE

Moscow ENERGOMASHINOSTROYENIYE in Russian No 4, Apr 86 pp 20-22

[Article by Candidates of Technical Sciences A.I. Generalov and V.Yu. Veroman]

[Abstract] Tool manufacture is a bottleneck on the road to automated manufacturing. Various ministries are now creating their own specialized plants for the manufacture process equipment and tools. Electric erosion hardening can achieve a savings in consumption of high speed tools by increasing operating life of tools by a factor of 1.5 to 4. Ultrasonic hardening of cutting edges using small diameter steel balls can also save tools. Vacuum-plasma application of hard carbides onto cutting tools is now being used. Electroplasma sharpening can reduce labor consumption in tool manufacture and increase the life of hard alloy tools. Combined electric erosion and abrasive grinding is quite effective. The combined use of electric working and computers facilitates the work of designers, technologists and workers in development and manufacture of tools. Photographs are presented of the "elitron-10" unit for electric erosion, hardening of cutting tools, a drill equipped with an ultrasonic head for cutting of threads in tough alloys and an electric plasma machine for cutting narrow slots for collection of condensate in steam turbine blades, a stamp for turbine blades manufactured by an electric pulse method and a numerically controlled electric erosion machine for automatic high-precision cutting of complex shaped apertures. No cost savings figures or examples of use are presented.

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AUTOMATION OF SELECTION OF MEASUREMENT TOOLS IN AN AUTOMATIC PROCESS PLANNING SYSTEM FOR MECHANICAL WORKING OF POWER MACHINE BUILDING PARTS

Moscow ENERGOMASHINOSTROYENIYE in Russian No 4, Apr 86 pp 23-24

[Article by V.V. Kalnitskiy]

[Abstract] "Atomkotlomash" Scientific-Production Association has developed and introduced a system for automatic technological preparation in the process of automatic planning of technological processes involving cutting, particularly the selection of measurement tools in the system for automated planning of the technological process of mechanical working of parts at "Krasnyy Kotelshchik" Production Association. This article describes the operation of the system. A flow chart outlines the stages involved in the process, including: data input, classification of dimensions by measurement method, determination of measurement accuracy, determination of type of measuring instrument, formation of a search description and search for a standard measurement instrument, formation of assignment for planning of a special measurement device if no standard instrument is found and inclusion of the new device in the file of standard devices. Figure 1, references 2.